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Popular Mechanics

SEPTEMBER 1997
VOLUME 174
NO. 9

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PM cover photo by Cliff Gromer
KENNETH GARRETT PHOTO MONTAGE (ABOVE)

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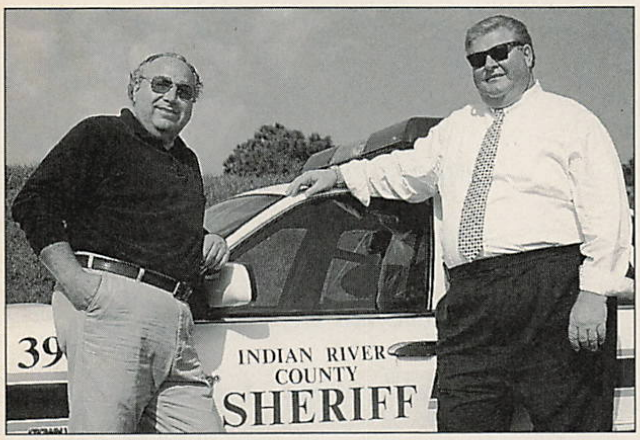
EDITOR'S NOTES

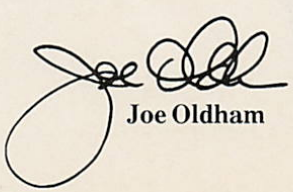
● **If you were asked to name the one jurisdiction** in the United States that uses the highest-tech, leading-edge techniques to train its law-enforcement officers, I'd bet a gazillion dollars you wouldn't say Indian River County, Florida. So you can understand my skepticism when Indian River County Sheriff Gary Wheeler called to invite me down to a demonstration of the Range 2000 system. Frankly, I would have blown off the invitation had not Contributing Editor Fred Mackerodt also touted the system's capabilities. Now, after seeing the system in operation, I'm glad I went. This is the kind of thing that makes you wonder why it took so long to develop it and why every police officer in the country isn't being trained on it. Sheriff Wheeler had the answer to the second part of that question: "Money." Yes, it's an expensive piece of technology. But how much is a human life worth? To Wheeler's way of thinking, a lot. Every law-enforcement official should have such sentiments....



SKIP GANDY PHOTO

Sheriff Wheeler (right) discusses perps with me.

Like trucks? You'll love "Extreme Trucks," which begins on page 58. It's Contributing Editor Cliff Gromer's survey of pickups and sport/utilities that are on the edge—on the edge of control as hundreds of horsepower pour through their powertrains. No question, trucks are the macho muscle machines of the '90s, and these are perhaps the machoest ever built.... **If you're following the buildup** of the Super Zodiac kit sportplane, you'll be glad to know the project is complete, FAA-approved and up and flying. Yours can be, too, once you read Gromer's final installment, which begins on page 68.... **Most small-craft boaters** don't realize what a difference in performance characteristics a change of props can make. Want better fuel economy? Want quicker acceleration? Change props. It's one of the quickest, simplest ways to change your boat's performance. Find out all about it in contributor John Wooldridge's report beginning on page 74.... **It's Ford versus Chevy** in our two Owners Reports this month. And while the Chevrolet Monte Carlo and Ford Contour do not actually compete head to head in the marketplace, it's always interesting when these two American automotive icons show up at the same time and place, like in this issue.... **Who couldn't use a few more phones in the house?** One of the features in this month's Home & Shop Journal shows you, step by step, just how to bring modern telecommunications to any household.... **And speaking of households, how about homes that grow themselves from the sea?** Fantastic? Yes, and no. It's a concept whose time may have come. Check out the report on page 54 by contributor Andy Turnbull. Till next time.



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Editor Rhonda H. Caguiat
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Editorial Administration
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Editorial Offices
224 W. 57th St., New York, NY 10019
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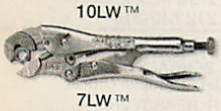
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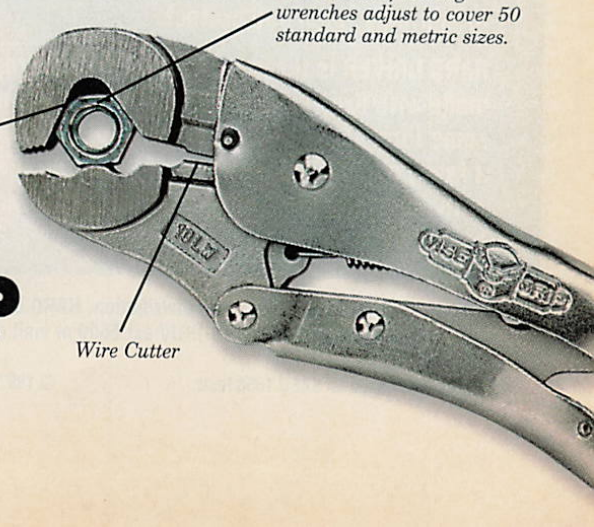

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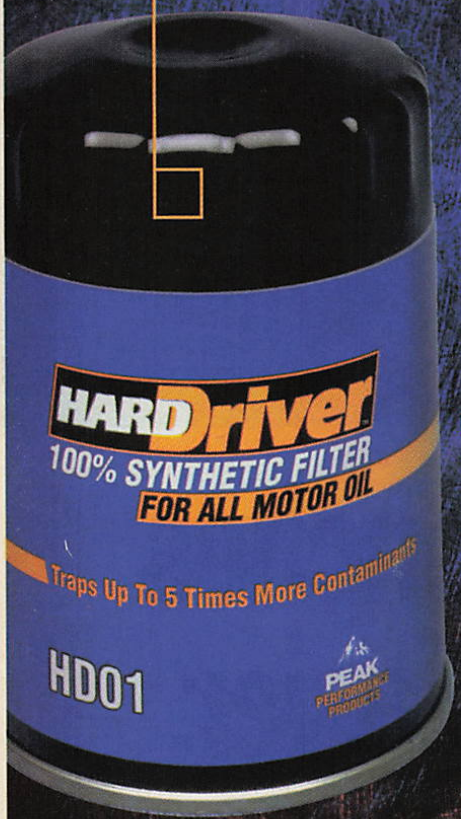

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Publisher Jay McGill

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ADVERTISING

Director Gregg R. Hano
212/649-3135

New York
224 West 57 St., New York, NY 10019
Tony A. Eason
212/649-3141
Gregory A. Messina
212/649-3142
Thomas H. Petersen
212/649-3039

Chicago
1 South Wacker Dr., Chicago, IL 60606
312/984-5190
Manager Richard T. Weithas
Spencer J. Huffman

Detroit
Hearst Magazines Sales, Inc.
2301 West Big Beaver Rd., Troy, MI 48084
810/649-2981
Manager Laurence E. Lantzy

Los Angeles
3000 Ocean Park Blvd., Suite 2002
Santa Monica, CA 90405
310/450-8881
Manager Michael T. Campbell

Atlanta
Erin M. Frank
1003 Potomac Rd., Atlanta, GA 30338
770/352-7652

Florida
Saba & Associates
4826 Cheval Blvd., Lutz, FL 33549
813/948-2088
Manager Ron Saba

Dallas
Ingersoll, Redding, Kellner & Zeko
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Account Executive Tammy Dennis
212/649-3167

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Promotion
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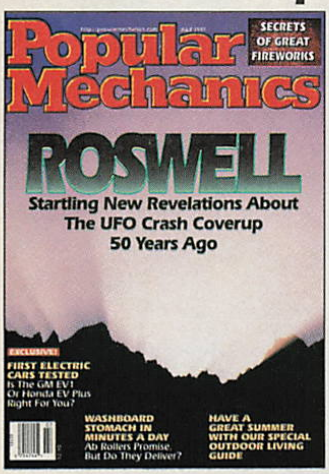
Cover Coverup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Finally! A sane voice in the sea of Roswell "experts." I congratulate you on a well-written and provocative article. With all the nut cases screaming about government coverups, ET sightings, secret bases and other strange and unusual stories, it is refreshing to hear someone offering a terrestrial explanation to the myth of the UFO.

CHUCK DAVIS
WESTMINSTER, CO

The only thing wrong with the 1947 Roswell alien crash is the media. When reporters have no personal background in the field they are reporting on, events are not reported correctly. To think that adults wouldn't know what Japanese people look like and mistake them for extraterrestrials is more beyond belief than having ETs here on Earth.

DR. ELLEN CRYSTALL
HAWLEY, PA

Your article was far superior to the one that appeared in *Popular Science* on the same subject. I believe you correctly guessed the true nature of this incident. What's amusing is that Americans have found it easier to believe that the mangled bodies of the crash victims in such a strange contraption were space aliens rather than highly skilled Japanese technicians. Propaganda really does work.

DR. LEWIS S. COLEMAN
VIA INTERNET

There are more important things than a fancy cover.

PAUL PATTERSON
COLUMBUS, OH

Many professional reputations have been ruined in the past 50 years trying to get the truth about UFOs to the American people. In my opinion, the real truth is bigger than we are, bigger than religion and, most important of all, bigger than our federal government.

LYNFORD D. TURNER
TUSTIN, CA

Your revelations about the Roswell incident are just another snow job of government disinformation.

DANIEL LOUDERBACK
SOUTH BEND, WA

Despite your disclaimer in the final paragraph of your article, you did nothing but reinforce already overactive imaginations concerning this event.

LEE M. WOOD
BOIS D'ARC, MO

Your article is one of the more balanced, rational treatments of the subject that I've read. Your analysis of new data offers more credible explanations than extraterrestrials.

KEVIN P. MURPHY
CHICAGO, IL

For more on Roswell, don't miss Science/Technology Editor Jim Wilson's Science column on page 38. —*Ed.*

Letters are subject to editing for length, style and format.

Fore Play

Thank you for featuring our swingless golf club in your magazine. We must point out, however, that the club can shoot a ball up to 250 *yards* up the fairway, not 250 *feet* as mentioned in the article. Also, a new corporation called GPower Inc. has been incorporated especially for the club. The club is no longer handled by the company featured in the article, Advanced Technologies Machine.

TRACY VIRGIL
GPOWER INC.
FREMONT, CA

We regret the error. —*Ed.*

We Hear You

Your article on digital hearing aids and Oticon Inc. did not represent the Widex Hearing Aid Co. favorably or with accuracy. Widex of Long Island City was not founded by former Oticon employees. It was founded by Henry Meltsner and Hal Spar, neither of whom ever worked for Oticon. The statement that Widex would not release its technical data is false. The Widex Senso is different from the Oticon Digifocus in that, among other things, the Senso offers 20-bit processing whereas the Digifocus offers 16-bit processing. The Senso is the only fully digital hearing instrument available as a nearly invisible, completely in-the-canal model.

DANA DULAS
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All of Joe's work is completely original. He doesn't work from plans or even pencil sketches. He designs as he builds.

It's good being Joe's neighbor. Much of his work overflows into the yards around him. Keep those power tools humming, Joe.

BILL RUSSELL
FRANKLIN SQUARE, NY

If your project is chosen as Reader Project Of The Month, you will receive a Stanley Home Improvement Kit, complete with hand and decorating tools, valued at more than $200. For your project to be considered, please send a clear, color photo and brief description to: Reader Project Of The Month, Popular Mechanics, 224 W. 57th St., New York, NY 10019.

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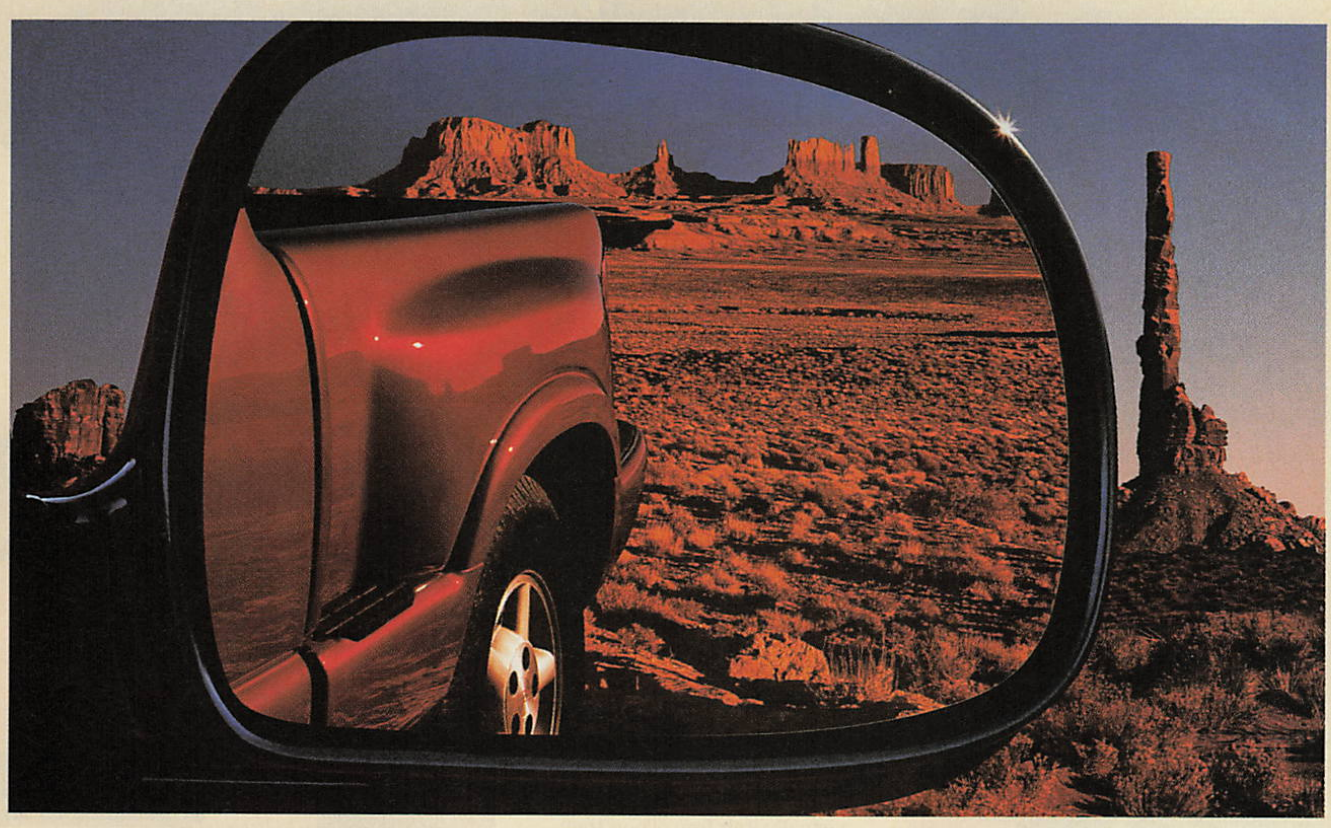

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As Johnny drove his Chevy™ S-10® Sportside™ deeper into no man's land, the sun shimmered along its curves. With its boldly styled fenders and intimidating beauty, it screamed for attention.

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For more information visit www.chevrolet.com or call 1-800-950-2438.

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Owens Corning scientists have virtually eliminated the itch in insulation.

Maybe we should take on poison ivy next.

Only Owens Corning innovation can offer you insulation that's virtually itch-free.

Most people just assume that insulation, like poison ivy, is going to make you itch. Fortunately, our scientists at Owens Corning challenged that assumption. After years of head-scratching research, they developed MIRAFLEX® insulation with its revolutionary, cottony soft fiber that's virtually itch-free. Then they poly-wrapped it for easy handling.

Start at the top: your attic.

Now it's more comfortable than ever to get up in the attic and install insulation for year-round savings*. The attic is where 40% of the energy is lost in a typical home. Adding *MIRAFLEX* R-25 insulation (8¼" thick) to your existing attic insulation is an easy project that can improve your insulating system year-round. Most homes need R-38 in the attic, which is equal to 12" of fiber glass blanket insulation. Our Home Energy Savings Kit offered in this ad includes the R-values recommended for your climate.

In projects all around the house, Owens Corning offers many ways to improve your home's insulating system. Each is designed to reduce the itch. Our PINK*PLUS*® insulation products come poly-wrapped to assure "less itch"

Insulating an attic is an easy do-it-yourself project that can save you plenty.*

Improve your home's insulating system, one project at a time, to save money on heating and cooling costs all year 'round.

OUTDOOR TIP

"Leaflets three, let them be." As the old saying goes, if the leaves on a plant stem are grouped in threes, chances are it's poison ivy.

PROJECT TIP

Take a few minutes to plan your insulating project and everything will go smoother. Make a list of all the steps involved and the tools required.

If you need advice, just give us a call.

*Savings may vary. Find out why in the seller's fact sheet on R-values. Higher R-values mean greater insulating power.

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during handling and installation.

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If your floors give you cold feet, warm them up with our PINK*PLUS* R-19 insulation (6¼" thick).

Adding value to room additions.

Enhance a room addition for long-term energy savings with PINK*PLUS* R-13 insulation (3½" thick) for 2x4 exterior walls. And add a layer of insulating system comfort with Owens Corning PINK FOAMULAR® rigid foam insulation. For 2x6 walls, use PINK*PLUS* R-19 insulation (6¼" thick).

Getting down to business in your basement.

Another simple project that can increase your home's living space is finishing your basement. Insulate those basement walls with PINK*PLUS* R-13 insulation (3½" thick) for 2x4 framing. Another easy-to-install option with plenty of insulating power is Owens Corning INSULPINK™ R-7.5 rigid foam insulation (1½" thick). Either way, your comfort will be greater during installation, and long after.

By insulating basement walls, your finished basement can feel as comfortable as the rest of your home.

Getting the shivers from drafty windows?

Replace them with energy-efficient Owens Corning vinyl windows. Our standard ¾" insulated glass helps keep indoor temperatures comfortable. And our durable sash and frame construction helps keep performance high. What's more, optional Low E/argon glazing helps keep heat from escaping in winter and keeps you cool in the summer.

Drafty windows can be replaced with high performance vinyl windows by Owens Corning.

Are energy savings hiding in your crawlspaces?

Additional savings can easily be achieved by insulating crawlspaces. *MIRAFLEX* R-25 insulation (8¾" thick) is ideal for virtually itch-free handling while insulating your crawlspace walls.

Insulating crawlspaces is a small project that can yield big results.

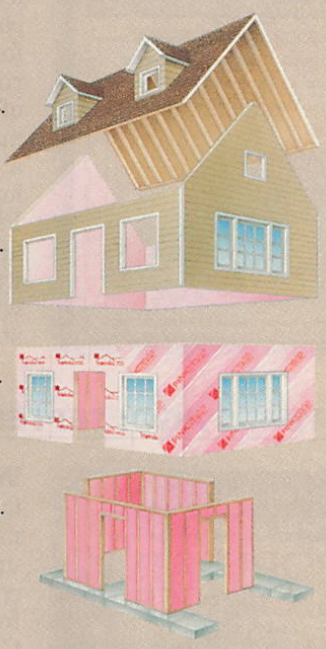
Don't give drafts even the smallest opening.

Finally, don't overlook the caulking and sealing of all cracks, joints and small openings inside and outside your home. Use non-hardening caulk in cracks. Seal those small openings tight with easy-to-apply Owens Corning Pinkseal™ foam sealant.

No matter which project you choose to do next, make sure you choose Owens Corning PINK insulating products. That's the best way to make sure your next home improvement project turns out right. With less itch.

After all, there's a system to these things.™

Your house is a series of systems. At Owens Corning, we want to help you understand how those systems work and how to make them work better. For free information or advice, call 1-800-GET-PINK *ext. 1026*



a. Roofing System – *Protects your home from the damaging effects of wind, rain, snow and sun.*

b. Exterior System – *Helps the outside of a house endure the elements beautifully, in trouble-free fashion.*

c. Insulating System – *Helps keep you warm in the winter and cool in the summer.*

d. Sound Control System – *Reduces the transmission of noise from adjoining rooms.*

FREE HOME ENERGY SAVINGS KIT

We know you're itching to find out more. For free information about our Insulating System, for a copy of our Home Energy Savings Kit, to locate a retailer, or to find an Owens Corning Certified Energy Professional insulation contractor, visit our web site at http://www.owenscorning.com *or call*

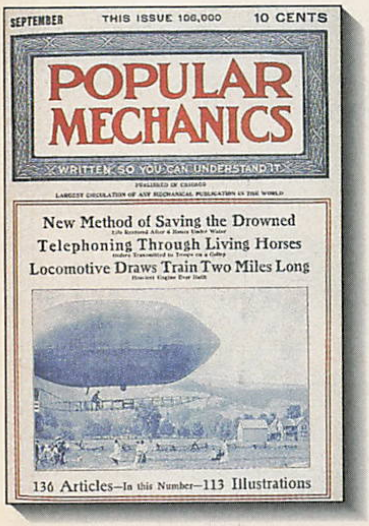
1-800-GET-PINK *ext. 1026*

OWENS CORNING

SYSTEM THINKING
for the Home™

TIME MACHINE

90 YEARS AGO: SEPTEMBER 1907

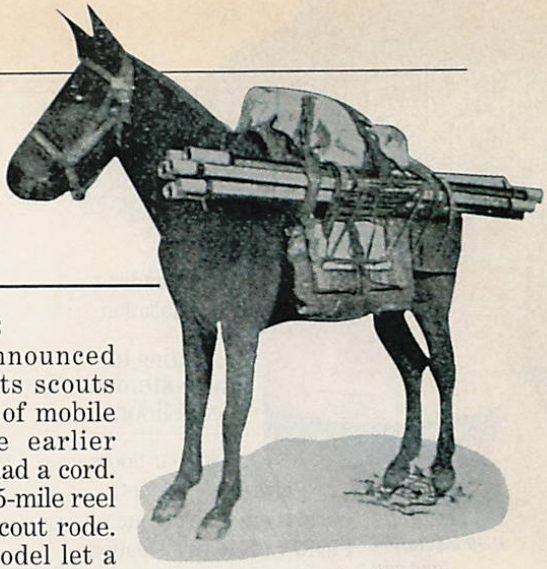


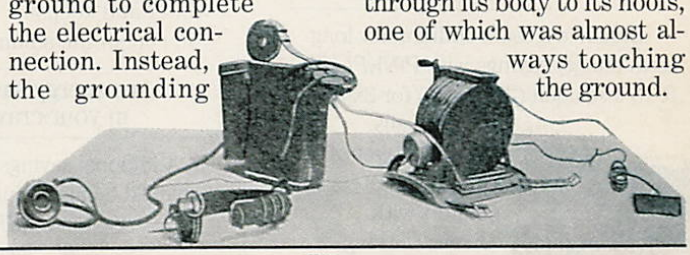
Precision Ballooning

Residents in Hammondsport, New York, saw a strange sight in the sky after Capt. T.S. Baldwin selected their placid farming community as the test site for his new airship. Baldwin rose to a dizzying altitude of 3000 ft. while sitting on a metal rail that was lifted by a gas bag measuring 52 ft. long and 17 ft. in diameter. PM reported that after half an hour of flying, Baldwin was able to land his craft within a few feet of his starting point.

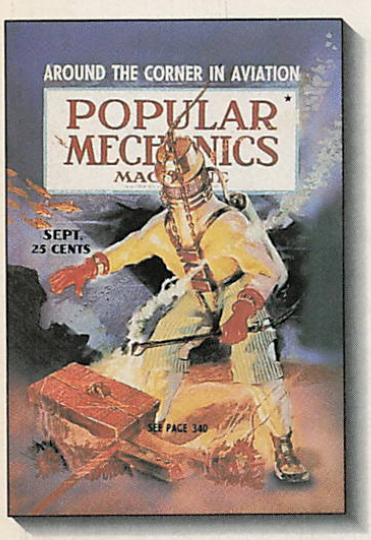
Wired Horses

The cavalry announced plans to equip its scouts with a new type of mobile telephone. Like earlier horse-phones, it had a cord. Wire stored on a 5-mile reel played out as a scout rode. The improved model let a rider make calls without having to first dismount and then drive a spike into the ground to complete the electrical connection. Instead, the grounding wire was attached to the horse's skin. The mild electrical current would pass through its body to its hoofs, one of which was almost always touching the ground.





60 YEARS AGO: SEPTEMBER 1937

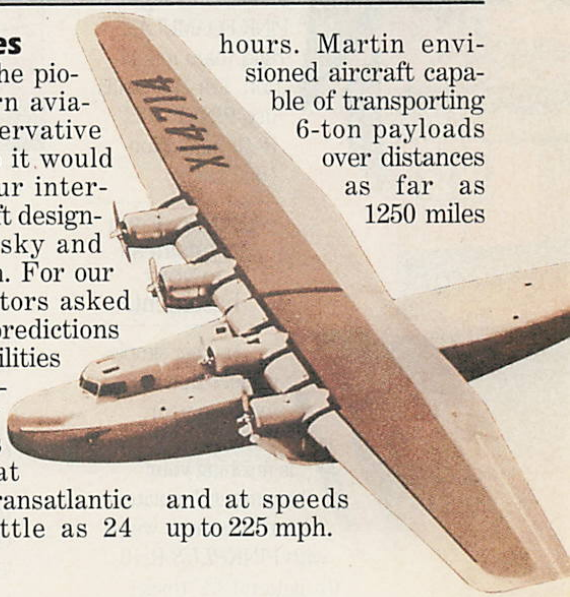


Wet Frontier

Over the years, PM documented the development of undersea technology. In the cover story of this issue, we focused on field tests of the Craig-Nohl self-contained diving suit. Like modern scuba apparatus, it freed the diver from an air line to the surface. The project was motivated by more than the quest for knowledge. Divers were looking for a means of recovering a safe aboard a rumrunner. It was reputed to have sunk with $250,000 in cash.

Future Planes

In retrospect, the pioneers of modern aviation were conservative thinkers. Or so it would appear from our interview with aircraft designers Igor Sikorsky and Glenn L. Martin. For our article, PM editors asked them to make predictions about the capabilities of future aircraft. Sikorsky described plans for a plane that could make a transatlantic flight in as little as 24 hours. Martin envisioned aircraft capable of transporting 6-ton payloads over distances as far as 1250 miles and at speeds up to 225 mph.



30 YEARS AGO: SEPTEMBER 1967

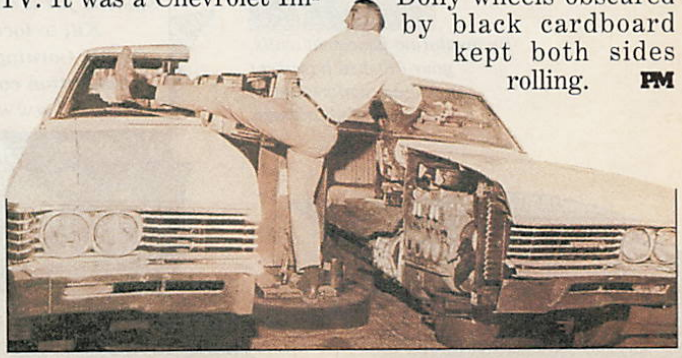
EXCLUSIVE! Preview of Great Gadgets and New Ideas from the World's Greatest Inventors Show
POPULAR MECHANICS
SEPT. 1967 35 CENTS
Clearing the Air on Those New Types of Tires
HOW FAST IS TOO FAST?
A Startling New Study on Driving Speeds by the Stanford Research Institute
Page 109
EXCITING NEW ONE-MAN HYDROFOIL
40 Pages of Ideas for Improving Your Home
HOW TO
Beat the Storage Shortage
Turn a Garage Into an Extra Room
Build Kitchen Cabinets • Install a Central Vacuum Cleaner • Pick the Right Window Glass
Plus More Tips, Tricks, and Shortcuts

Solo Hydrofoil

Touring the Inventors Show at the New York Coliseum, our editors found the ultimate adventure craft: the 1-man hydrofoil. Powered by a conventional 18-hp engine, the foam-filled fiberglass hull of this Italian-designed craft could streak on the water's surface at 35 mph. The excitement came not so much from its speed as from the rider's position. He lay on his belly, low to the water, and steered the hydrofoil as if he were riding headfirst on a child's sled.

Split Personality

PM explained how special-effects wizards created the car used in the most astounding commercial on TV. It was a Chevrolet Impala Super Sport that could split down the middle while driving down the road, then, just as mysteriously, rejoin itself. The secret: Dolly wheels obscured by black cardboard kept both sides rolling. **PM**



TECH UPDATE

News Of Tomorrow's Technology Today

Control surfaces on the front delta wing make the UCAV highly maneuverable.

NORTHROP GRUMMAN ILLUSTRATIONS

First Look At Next-Generation Stealth Fighters

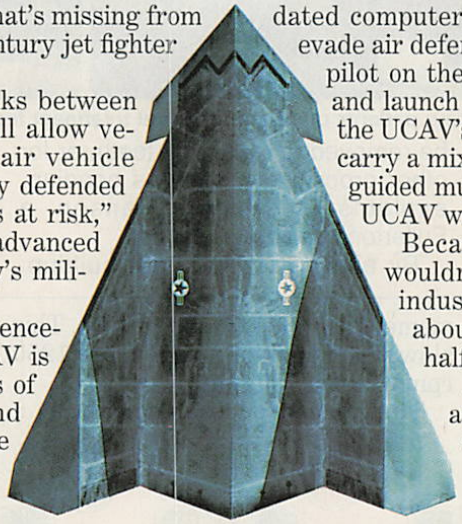
EL SEGUNDO, CA—The only thing that's missing from Northrop Grumman's proposed 21st-century jet fighter is an ejection seat for the pilot.

"Emerging use of real-time datalinks between controllers and a weapons system will allow vehicles like the uninhabited combat air vehicle (UCAV) to penetrate and attack highly defended target areas without placing air crews at risk," says Greg Zwernemann, manager of advanced uninhabited concepts for the company's military aircraft systems division.

Looking like something out of a science-fiction movie, the 27-ft. gull-wing UCAV is intended for the most dangerous types of missions: air defense suppression and deep strikes. Its base-to-target range will be comparable to an F-16 at about 800 miles.

A typical flight would begin with the UCAV using GPS to navigate toward its target. Its tailless design presents a small radar cross section, thus improving its chances of penetrating enemy airspace at subsonic speeds.

Once over hostile terrain, the craft would rely on stealth technology originally developed for the B-2 bomber to avoid radar detection. A constantly updated computerized flight plan would help the UCAV evade air defenses. Once the plane is near the target, a pilot on the ground would remotely verify targets and launch weapons. The company will not specify the UCAV's payload capacity, other than to say it will carry a mix of 250-, 500- and 1000-pound precision-guided munitions. After it released its bombs, the UCAV would be able to fly home unassisted.



Because the planes would be smaller and wouldn't require a pilot life-support system, industry insiders estimate they would cost about $12 million each, which is less than half as much as a conventional F-16.

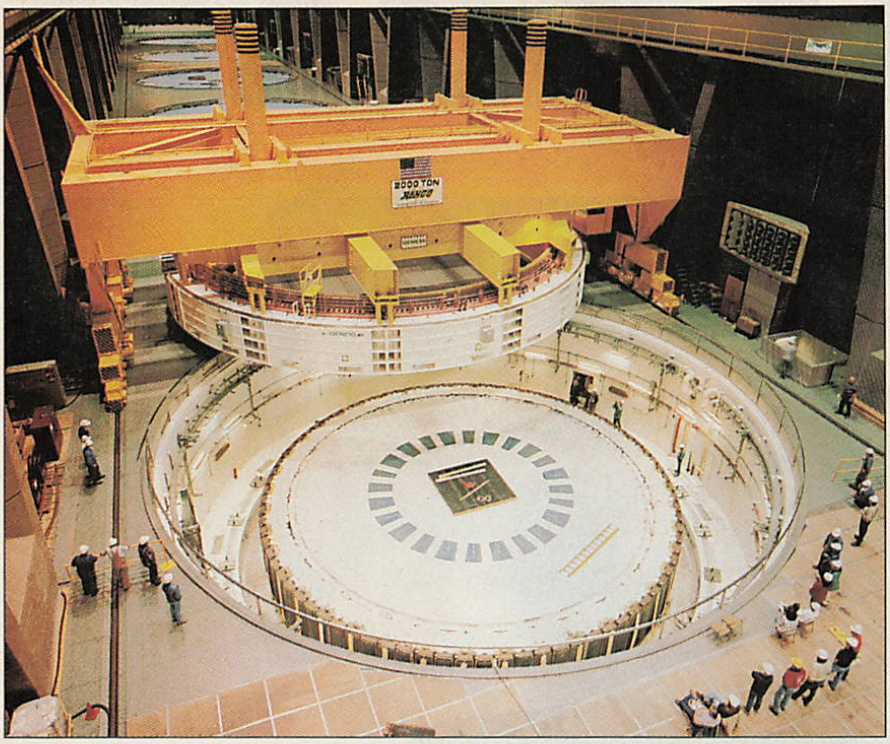
Although the Pentagon has not officially announced it is interested in buying unmanned jet fighters, the company's efforts have already progressed as far as wind-tunnel testing.

Editor/Writer: Jim Wilson
Reporters: Chris Dean, Mike Fillon, Bill Garvey, Scott Gourley, Cliff Gromer, Barry Rosenberg

Highlights This Month

- **Power Shift**—World's largest hydrogenerator repair.
- **Paris Air Show**—Highlights from world's biggest exhibit.
- **Nuclear Alert**—Accidents plague Japanese atom plants.
- **Before Leonardo**—Working models of early wonders.
- **Mostly Air**—Smaller cells create ultradense plastics.
- **Life Preserver**—Sea monkey protein aids immortality.
- **Teflon Plants**—Nonstick coating comes to dress clothes.
- **Cheap Chills**—Old ideas cut refrigerator energy costs.

(More Tech Update on page 20)



SIEMENS PHOTO

Siemens Power designed special construction equipment to place the 75-ft.-dia. stator.

Huge Generators Get A Tuneup

COULEE DAM, WA—Hydroelectric generation is perhaps the most reliable way to make electrical power. But when the time comes to make repairs, the task is usually a whopper.

One such project is under way at the Grand Coulee Dam, which spans the Columbia River about 85 miles northwest of Spokane, Washington. Siemens Power Corp. describes it as one of the largest hydrogenerator rebuilding efforts of its type in the world.

Begun shortly after Siemens won a U.S. Bureau of Reclamation contract in 1992, the work involves the design, manufacture and extensive testing and installation of three new stator cores for the dam's G22, G23 and G24 generators. Rated at 836 megawatts, the trio holds the world record for power generation. The rebuilding will make them even more energy-efficient.

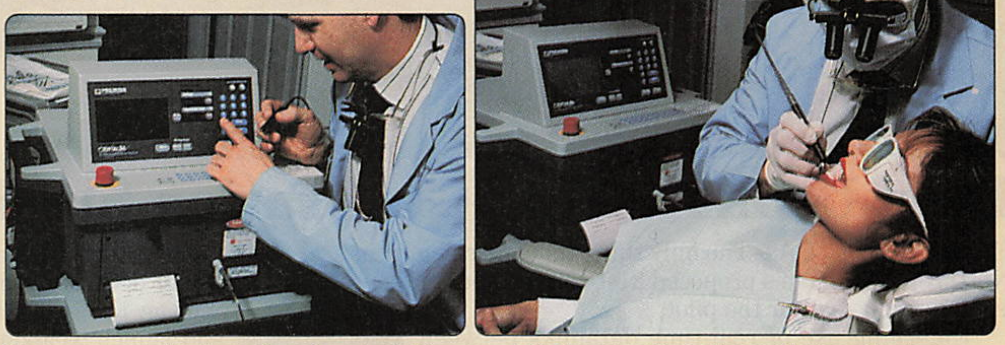
The generators should go back online within the next three months.

A Light Approach To Cavities

IRVINE, CA—A new instrument promises to extract some of the anxiety from visits to the dentist. Premier Laser Systems has begun shipping a laser powerful enough to replace the dental drill.

The system uses an erbium yttrium aluminum garnet laser to deliver bursts of 2.94-micron-wavelength light through flexible fiberoptic cable. When this tightly focused beam of energy comes in contact with moisture on the surface of the tooth, the water is rapidly vaporized. The resulting shock wave neatly nibbles at cavities, or healthy tissue that must be removed to repair the teeth, or for other procedures, such as bonding, explains Dr. Richard Hansen, a Fullerton, California, dentist.

By eliminating the heat buildup, vibration and noise caused by today's drills, the laser can often remove the need for a needle full of anesthesia. Now, if someone would only invent a laser that blasts a hole in dental bills.



PREMIER LASER SYSTEMS PHOTOS

Hansen says patients undergoing dental treatment feel a sensation of warmth from the laser.

Shifting Without A Transmission

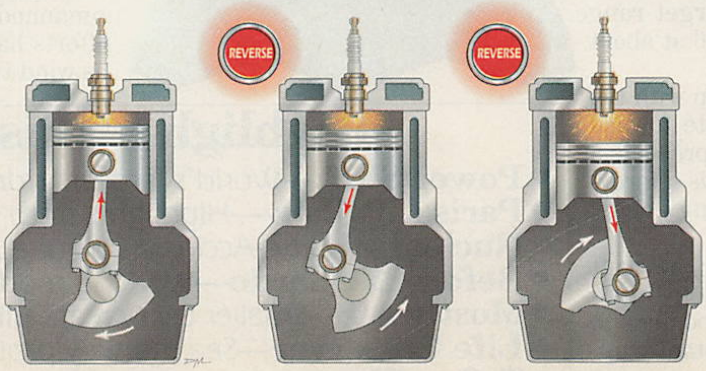
WAUSAU, WI—Weight and complexity are the enemies of snowmobile performance. So the engineers at Bombardier Inc. came up with the novel idea to run their Ski Doo sleds in Reverse. They changed some of the programming on the microprocessor that adjusts the ignition timing so that the 2-stroke engine can run backward.

Here is how it works: Pushing the Reverse button while the engine is idling momentarily cuts off the ignition. This slows normal idle speed from 1250 rpm to about 500 rpm.

The microprocessor calculates a time delay in accordance with a predetermined relationship between rotational speed, the engine's direction and the spark advance.

The ignition then kicks back in at between 30° and 40° before top dead center (BTDC), creating a sort of internal backfire. It creates sufficient energy to overcome the piston's inertia and reverse its direction. To return to Forward, the driver presses the Reverse button a second time.

Look for the feature on some of this year's models.

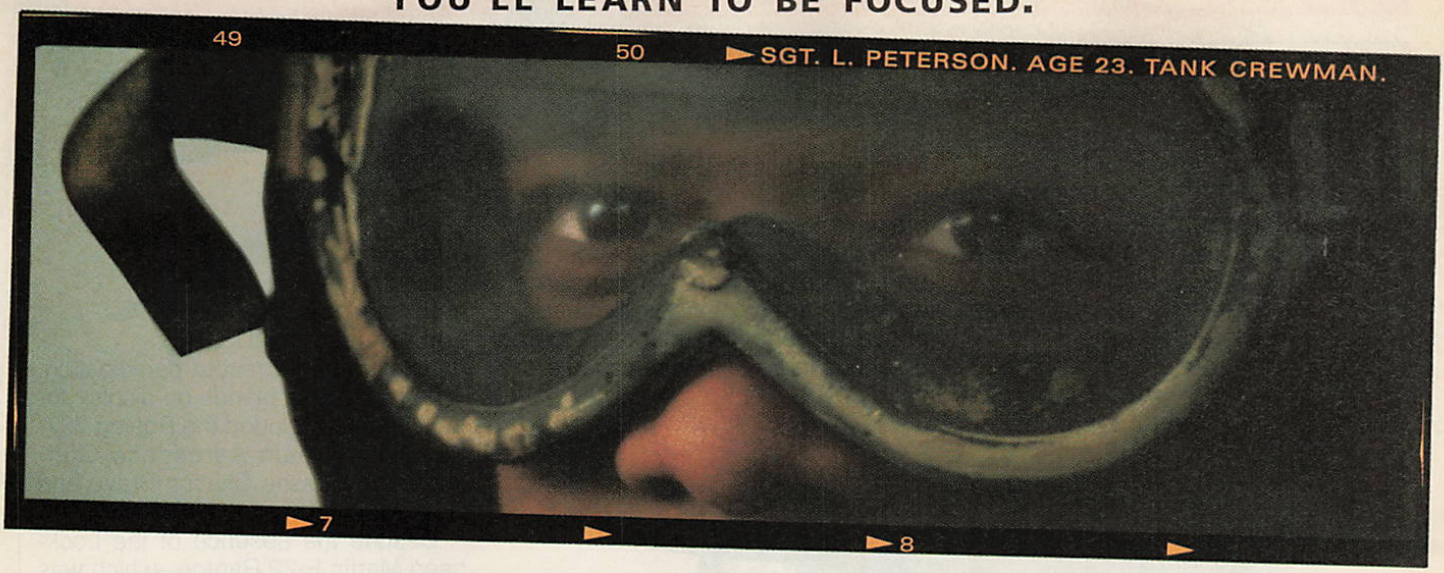


Split-second timing is the key to making a forward-running engine reverse direction.

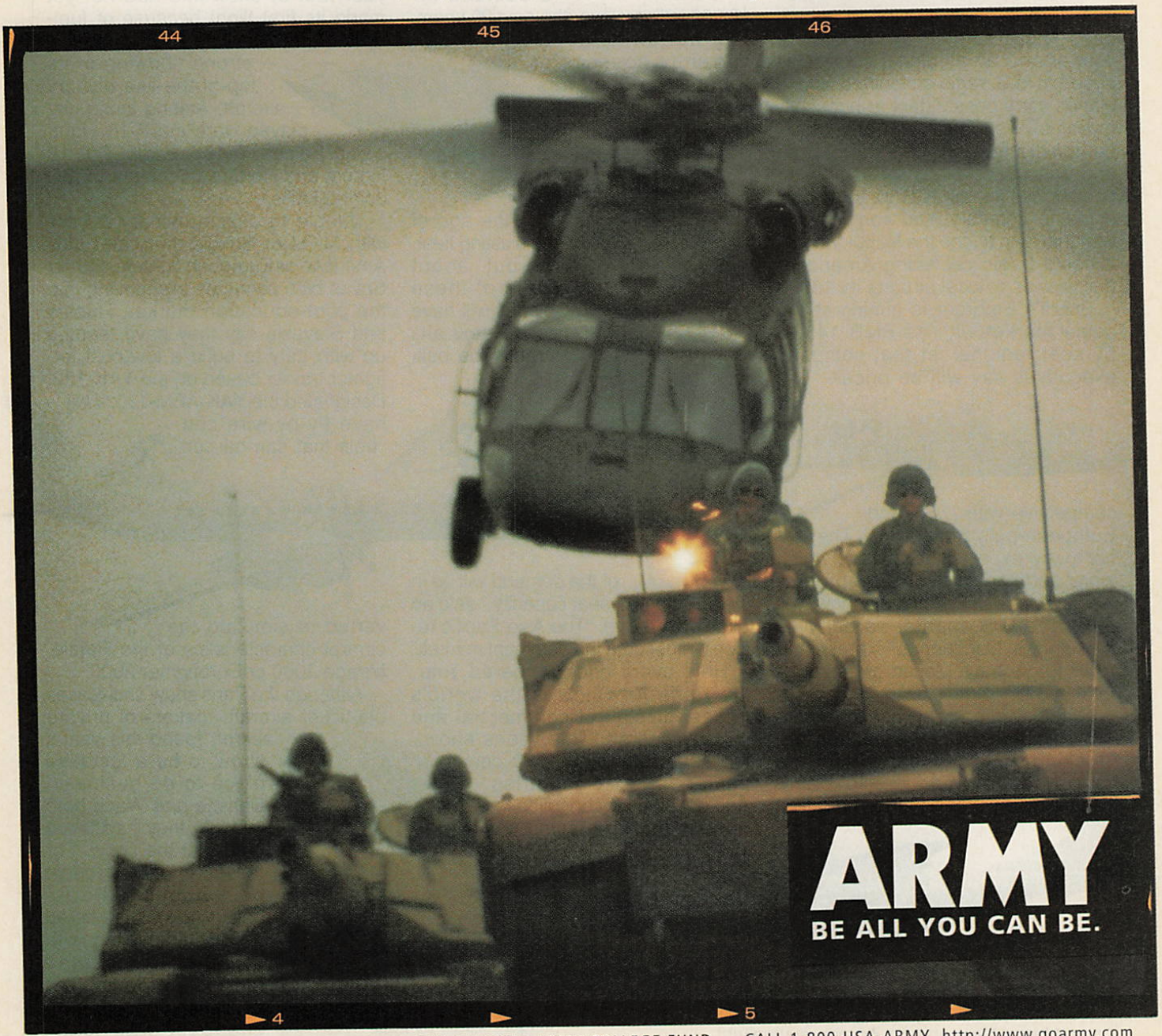
PM ILLUSTRATION BY DON MANNES

(More Tech Update on page 22)

YOU'LL LEARN TO BE FOCUSED.



SO WHEN YOU GET $40,000* FOR COLLEGE, YOU'LL BE READY.



*IF YOU QUALIFY FOR THE MONTGOMERY GI BILL PLUS THE ARMY COLLEGE FUND. CALL 1-800-USA-ARMY http://www.goarmy.com

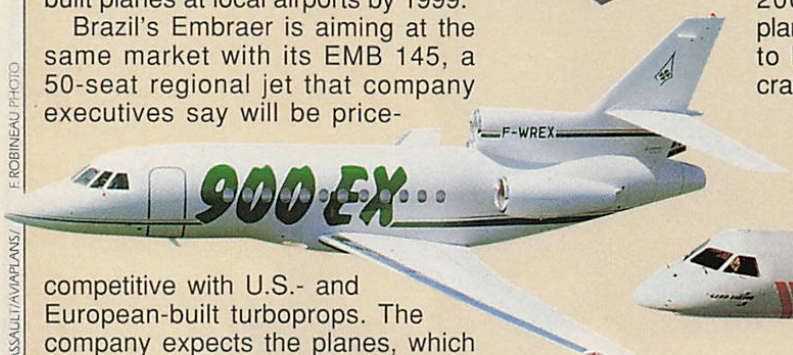
The 1997 Paris Air Show

LE BOURGET, FRANCE—The big news at this year's Paris Air Show came from Third World and developing nations.

Indonesia's Industri Pesawat Terbang Nusantara (IPTN) impressed airline executives with flight performances by its N250 series 54- and 68-seat turboprops. The plane, which uses such features as fly-by-wire control and an all-digital cockpit, is aimed at U.S. regional airlines whose planes carry passengers to hubs in major cities. The company also demonstrated a coastal patrol craft and announced plans for a turbofan commercial jet, the N2130, to be built in the next century. You won't have to wait that long to see the N250, though. It could begin replacing American-built planes at local airports by 1999.

IPTN ILLUSTRATION

Brazil's Embraer is aiming at the same market with its EMB 145, a 50-seat regional jet that company executives say will be price-competitive with U.S.- and European-built turboprops. The company expects the planes, which were certified to fly in Europe only weeks before this year's air show, will enter the U.S. market as early as next spring. Continental Express and AMR Eagle have placed orders for a total of 67.

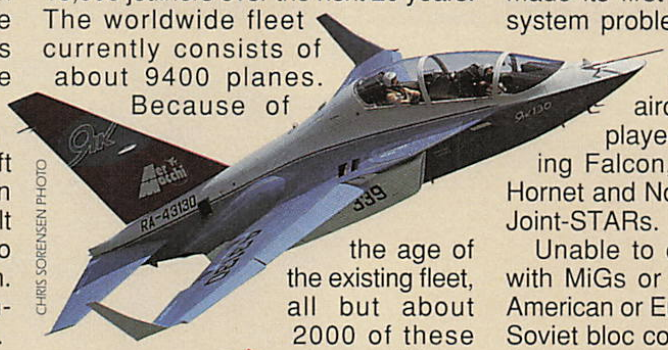


DASSAULT/AVIAPLANS/F. ROBINEAU PHOTO

One indication of how seriously the established turboprop makers are taking their new competitors in the developing world came from Sweden's Saab Aircraft. It announced a limited-term free maintenance program for future buyers of its Saab 2000.

IPTN PHOTO

Makers of larger passenger jets don't appear to be too concerned about the arrival of the newcomers. A forecast of the airline market prepared by Airbus Industrie and released at the show projects a demand for 16,000 jetliners over the next 20 years. The worldwide fleet currently consists of about 9400 planes. Because of the age of the existing fleet, all but about 2000 of these planes will have to be new aircraft. "The bulk of the demand will be in the 100- to 400-seat capacity," said an Airbus executive. "The Asia-Pacific region will become the dominant market."



CHRIS SORENSEN PHOTO

Held every odd-numbered year, the Paris Air Show is the world's largest display of commercial and military aircraft. This year's show, the 42nd, attracted 1760 companies from 42 countries. And despite the consolidations that are taking place among American aerospace companies, the U.S. delegation had a record participation. American-made planes on display for the first time included the Boeing 737-700, Gulfstream Aerospace Gulfstream 5, Cessna Citation Bravo and Citation Excel.

EMBRAER PHOTO

Despite the absence of the Lockheed Martin F-22 Raptor—which was rolled out of the hangar earlier this year, but at showtime had not yet made its first flight because of fuel-system problems—the U.S. made a strong showing of its top-of-the-line military aircraft. Among those displayed were the F-16 Fighting Falcon, F-15E Eagle, F/A-18 Hornet and Northrop Grumman E-8C Joint-STARs.

Unable to dazzle military buyers with MiGs or Sukois that can outfly American or European fighters, former Soviet bloc countries are moving into the pilot-education market. Russia and Slovakia say they have teamed up with Italy to build a low-cost jet-fighter trainer based on the YAK-130. Designated the YAK-AEM-130, it will have fly-by-wire controls that can be converted to simulate the control characteristics of the Rafale, Mirage 2000 or Eurofighter 2000.

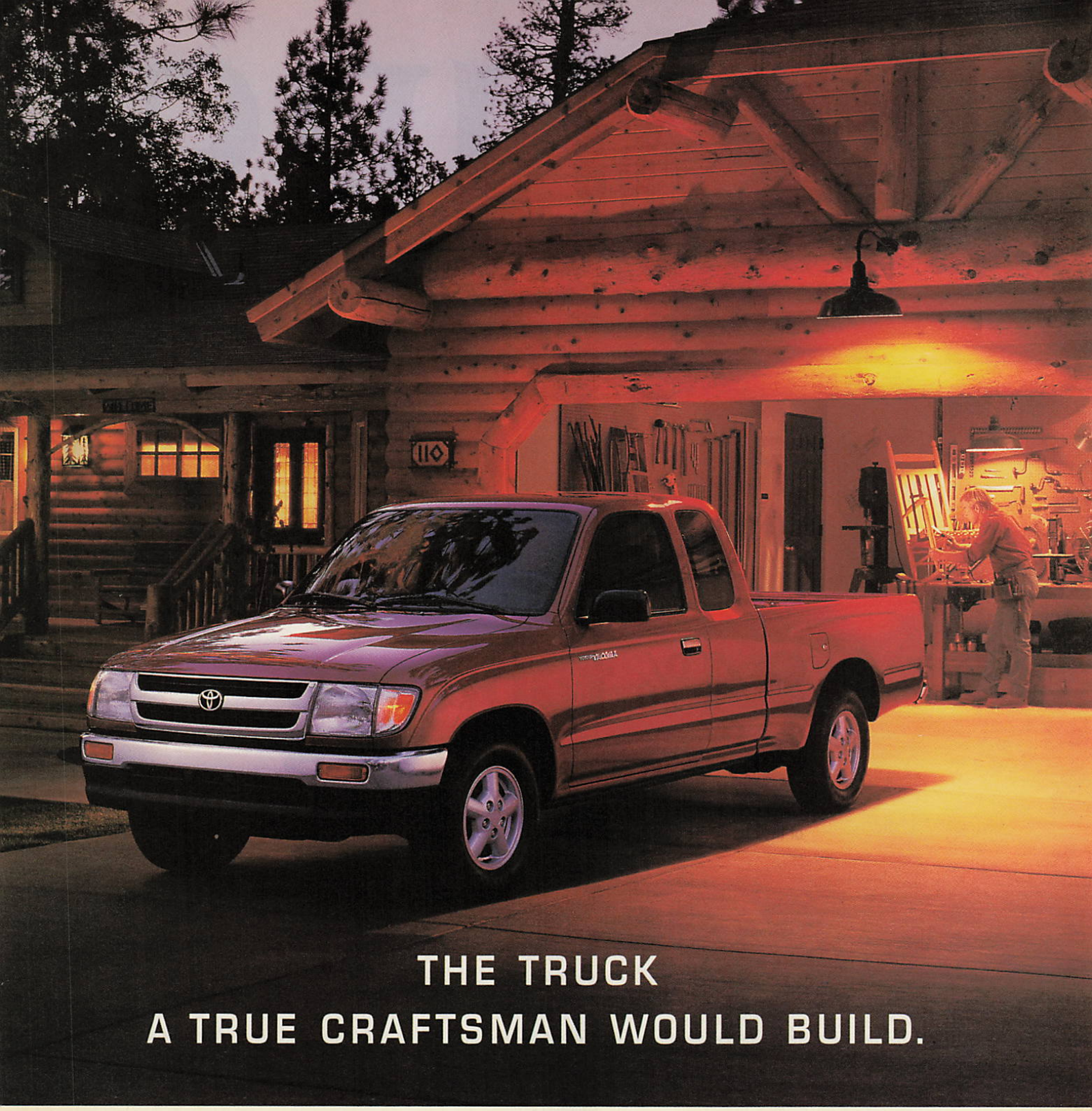
SAAB AB/J. LINDAHL PHOTO

Although the Paris show showcases big-ticket aircraft, makers of private aircraft found this year's show to be a lucrative place to do business. Cessna and Waco both told PM they had taken orders at the show. For those with more modest pocketbooks, Paris-based Adventure offered a paraglider wing with a backpack-mounted fan. It's not fancy, but at $6000, it was the cheapest way to fly home from the show.

ADVENTURE PHOTO

Head turners at this year's show included (top to bottom) Embraer EMB145, IPTN's proposed 132-passenger turbofan, the YAK-AEM-130 Trainer, Dassault Aviation's Falcon, the Saab 2000, IPTN's CN-235 Coastal Patrol Plane and the Adventure ultralight.

(More Tech Update on page 26)



THE TRUCK A TRUE CRAFTSMAN WOULD BUILD.

Attention to detail, craftsmanship and quality. The Toyota Tacoma. Once again declared "The Best Compact Pickup Truck" in the 1997 J.D. Power and Associates Initial Quality Study.* Tacoma was designed for those who strive to improve upon perfection and build a masterpiece that will stand the test of time. Tacoma 4x2 has the highest standard payload and towing capacities in its class. Add to this an available 190-hp V6, and you simply can't buy a more powerful truck. Toyota Trucks. Always come through.

Call 1-800-GO-TOYOTA or visit our Web site at: www.toyota.com for a brochure or full-line CD-ROM plus the location of your nearest dealer. ©1997 Toyota Motor Sales, U.S.A., Inc. Buckle Up! Do it for those who love you. *The Tacoma is the highest-ranked compact pickup in the J.D. Power and Associates 1997 Initial Quality Study.℠ 1997 Study based on a total of 43,752 consumer responses indicating owner-reported problems during the first 90 days of ownership.

TOYOTA TACOMA

I love what you do for me

YOURS.*

94% tobacco
6% additives

*Laboratory analyses of the top ten U.S. non-menthol brand styles show all of their tobaccos contain a minimum of 6% additives on a dry weight basis.

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16 mg. "tar", 1.1 mg. nicotine
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OURS.

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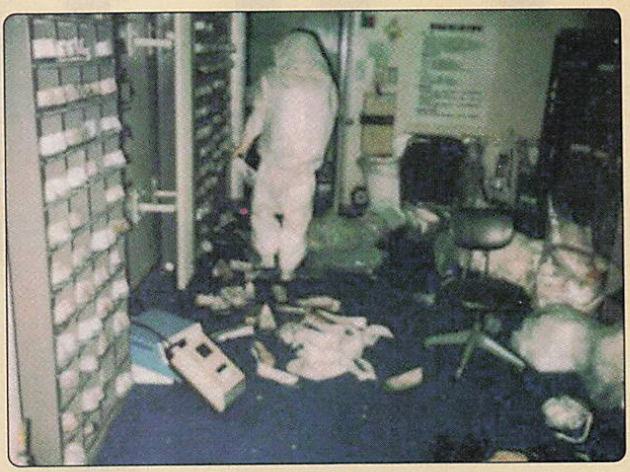
Bad Year For Japan's Nukes

TOKAL, JAPAN—The revelation that two nuclear accidents were more serious than initial reports disclosed has set back this fuel-poor nation's plans to increase its reliance on atomic power to 42% by 2010.

Japan's worst nuclear accident occurred at a plutonium reprocessing plant here in March, when an explosion exposed 37 workers to low-level radiation. Some time after the first announcement, it was disclosed that officials had detected radiation more than 23 miles away.

A month later, Tokyo Electric Power was forced to temporarily shut down its plant and engineers subsequently traced a radiation leak to a pinhole-size opening in a nuclear fuel rod.

"The accidents may affect plans to build more nuclear power plants in general," said Kazuya Fujime, a senior researcher at Japan's Institute of Energy Economics and a longtime supporter of nuclear power.



An inspector assesses damage after an explosion blew windows out of a plutonium reprocessing plant.

AFP/JIJI PHOTO

Before striking a target, a beam passes through a cloud of reactant and is then cooled.

UNIVERSITY OF BUFFALO/DON HEUPEL PHOTO

Laser Triggers Novel Reactions

BUFFALO, NY—A new chemical-reaction technique called laser-assisted molecular beam deposition (LAMBD) has made it possible to create what were once considered impossible chemical reactions.

LAMBD is an improvement on "sputtering," in which heat drives molecules from a donor material to a target. "Instead of simply sputtering a target material from point A to point B, we're chemically modifying it at the same time," explains James F. Garvey, the State University of New York chemistry professor who developed the process. The 1-step process also eliminates toxic byproducts, he says.

Garvey believes that the first application of LAMBD will be in making chips for supercomputers.

Antifreeze To Cool Future Cannon

PICATINNY, NJ—For future gunners, the order to "change the antifreeze" may soon take on a whole new meaning.

While firing at its maximum specified rate of 60 rounds in 5 minutes, the Army's next-generation 155mm cannon, the XM-297E2, generates an unprecedented amount of heat. So much, in fact, that the cannon's tube would be quickly ruined if it wasn't designed to more rapidly disperse heat.

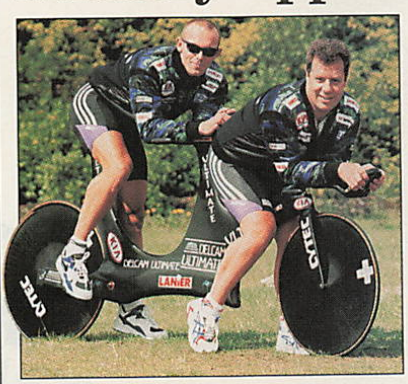
One solution is to circulate a 50/50 mix of water and ethylene glycol—basically, diluted antifreeze—through a series of channels cut into the tube's integrated midwall.

Two prototypes will be installed on next-generation "Crusader" testbeds next year. If field tests are successful, the high-performance 155mm cannon could go into service in 2005.

Cross section of the future cannon's integral midwall cooled tube.

SCOTT GOURLEY PHOTO

Military Approach To Bike Design



The Delcam Ultimate Tandem has been clocked at a record 207.9 mph.

NORFOLK, ENGLAND—Bicycle enthusiast Bruce Bursford has produced the world's fastest bicycle built for two by applying design tools and materials that are used to develop military aircraft.

To achieve this breakthrough, Bursford used the same software used by the British defense industry. Monocoque construction, like that used in fighter-jet wings, replaced the tube frame. Carbon composite replaced the rubber in the wheels.

This technology is expected to spill over into the civilian sector soon, in the form of a new generation of superlight bikes, including an 11-pound solo model.

PRESS ASSOCIATION PHOTO

This Crop-Duster Really Delivers

ALBANY, GEORGIA—Best known for its Thrush crop-dusters, Ayres Corp. will soon make a new type of delivery. Federal Express (FedEx) plans to build a fleet around the new Loadmaster LM200.

The close collaboration between the delivery service and the aircraft company shows in the boxy design of the fixed-gear, unpressurized 69-ft. aircraft. Intended to serve feeder routes, the Loadmaster is powered by a pair of LHTEC 2400-shaft-horsepower turbine engines that drive a single propeller.

Plane's 1350-cu.-ft. cargo hold accepts full-size LD-3 cargo containers.

FedEx expects to take delivery of its first two aircraft in 1999.

Although it looks a bit cartoonish with its long snout dwarfing its cockpit windows, the Loadmaster can haul 7500 pounds of freight 600 nautical miles.

AYRES CORP. PHOTO

(More Tech Update on page 28)

Not all radios are created equal.

Bose® takes radio to a new level.

Most radios leave a lot to be desired—rich, lifelike sound, for instance. That's why Bose, the most respected name in sound, created the Bose Wave® radio. It literally redefines tabletop radio, so you can enjoy Bose quality sound almost anywhere. Like your living room, bedroom, kitchen, or office.

The Wave radio sounds as rich and lifelike as many full-sized stereo systems, despite its small size. In fact, many owners use their Wave radio as their primary stereo.

The key to the Wave radio's high-fidelity sound is our patented acoustic waveguide speaker technology. Just as a flute strengthens a breath of air to fill an entire concert hall, the waveguide produces room-filling sound from the Wave radio's small enclosure. *Popular Science* was so impressed, they honored the Wave radio with a "Best of What's New" award.

Unique features make it very easy to use.

The Wave radio comes complete with a handy credit card-sized remote control, dual alarms, and six AM and six FM station preset buttons. (A combination of features you won't find with any other radio.)

You can even bring award-winning Bose sound to recorded music, TV programs, or movies by connecting the Wave radio to your CD or cassette player, TV, or VCR. And the Wave radio measures just 4.5″H × 14″W × 8″D, so it fits almost anywhere.

Popular Science called it "a sonic marvel" and gave it a prestigious "Best of What's New" award. Business Week named it a "Best New Product of 1994." What will you say when you hear the Bose Wave radio?

Call now and make six interest-free payments.

Engineered and manufactured in the United States, the Wave radio is available for $349 directly from Bose.

Call 1-800-845-BOSE, ext. R5385, or return the coupon for free information or to learn more about our in-home trial and satisfaction guarantee. When you call, ask about our convenient six-month payment plan.

If you love music, call today. Because you haven't truly heard radio until you've heard the Bose Wave radio.

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☐ Pearl White ☐ Graphite Gray

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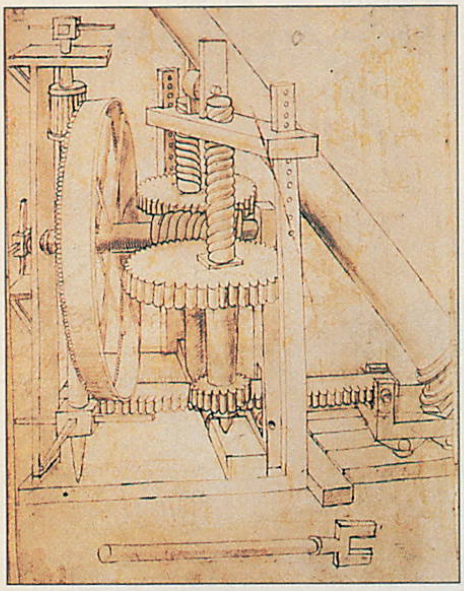
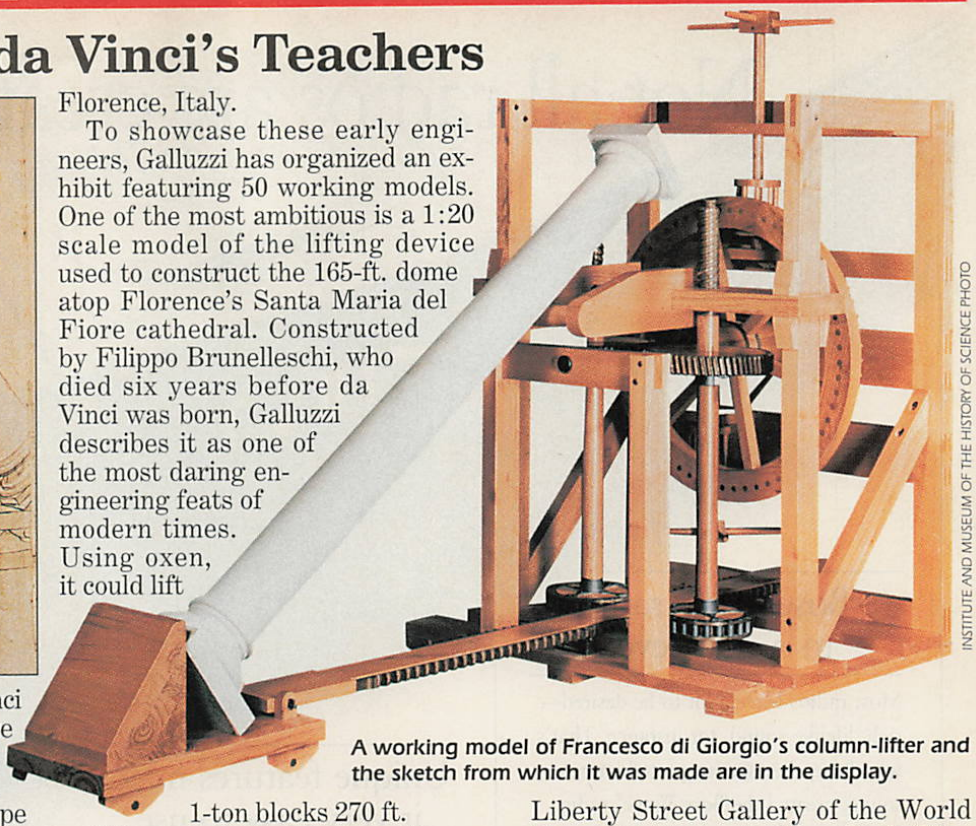
Exhibit Honors da Vinci's Teachers



NEW YORK, NY—Leonardo da Vinci may be the best-known Renaissance engineer, but he wasn't the first. In fact, a full-blown technological revolution had swept through Europe before da Vinci was born, says Paolo Galluzzi, director of the Institute and Museum of the History of Science, in Florence, Italy.

To showcase these early engineers, Galluzzi has organized an exhibit featuring 50 working models. One of the most ambitious is a 1:20 scale model of the lifting device used to construct the 165-ft. dome atop Florence's Santa Maria del Fiore cathedral. Constructed by Filippo Brunelleschi, who died six years before da Vinci was born, Galluzzi describes it as one of the most daring engineering feats of modern times. Using oxen, it could lift 1-ton blocks 270 ft.



INSTITUTE AND MUSEUM OF THE HISTORY OF SCIENCE PHOTO

A working model of Francesco di Giorgio's column-lifter and the sketch from which it was made are in the display.

This exotic lifting device will go on display along with 49 other examples of Renaissance engineering at the Liberty Street Gallery of the World Financial Center in New York City, from Oct. 24 until March 1, 1998. A cyber version will be on the Internet.

NASA PHOTO

The lens of the camera is an array of specialized radio receivers.

Radio Camera Sees Through Fog

REDONDO BEACH, CA—A new type of camera capable of seeing through clouds, dense fog, smoke and dust is being developed for military and civilian use.

Normal cameras gather light from the visible-light portion of the electromagnetic spectrum. In contrast, the passive millimeter wave camera looks at another portion of the spectrum, which is less affected by the obscuring effects of the water vapor contained in clouds and fog, and the particulate matter in smoke and dust.

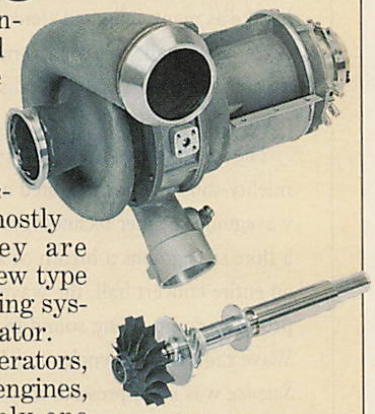
A proof of the concept camera that was constructed by TRW engineers consists of a 1040-element focal plane array that collects signals in the millimeter range. Receivers tuned to this frequency and signal-processing electronics then convert the signals into an image similar to video. The camera is being developed under a Defense Department dual-use program intended to speed the adoption of military technology in the civilian sector.

The first application of the camera is likely to be as a landing aid for specialized aircraft.

Jet Challenges Utilities

CHICAGO, IL—Jet engine technology may land right beside your favorite convenience store.

AlliedSignal says that because these stores are large consumers of electric power—they use it mostly for refrigeration—they are prime customers for a new type of self-contained generating system called a TurboGenerator.



TurboGenerators can be ganged to handle heavy loads, and they can run on a variety of liquid or gaseous fuels.

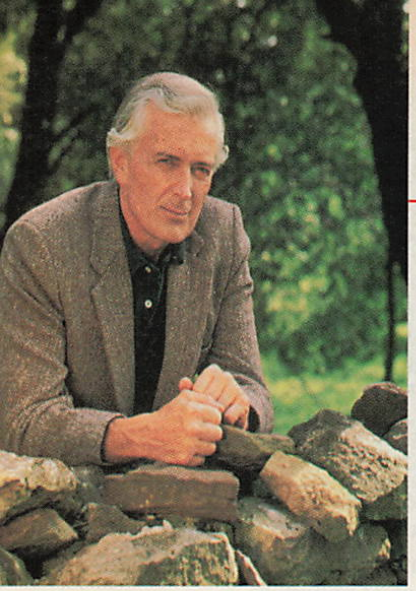
Unlike current co-generators, which use reciprocating engines, the new system has only one moving part. "We think this is as significant as the diesel engine. There is only one moving part in the TurboGenerator," explains Tony A. Prophet, president of AlliedSignal Power Systems.

The single moving part is a shaft that incorporates turbine blades and the rotating portion of a generator, which also functions as the unit's starter motor. The entire unit is about the size of two commercial refrigerators placed back-to-back.

TurboGenerators will make their first appearance in Illinois this fall.

ALLIEDSIGNAL PHOTOS

(More Tech Update on page 30)



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Built-in stereo speakers and microphone
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STANDARD FEATURES
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PCI graphics accelerator, 2MB VRAM
8X modular CD-ROM drive
Pick-a-Point dual pointing devices
Sound Blaster 16-bit stereo sound
Built-in stereo speakers and microphone
Motorola Montana 33.6 fax/modem
CardBus-and zoomed video-ready
2 infrared ports, 1 front, 1 rear
S-video and NTSC-video capability
Built-in game port
Management Pak, Executive Travel Pak
2 modular expansion bays (hard drive, CD-ROM drive, 3.5" floppy drive, lithium-ion battery)
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PCI bus with 128-bit graphics accelerator
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Zoomed video-ready
Touchpad pointing device
16-bit stereo sound
Built-in stereo speakers and microphone
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THINKING OUT OF THE BOX

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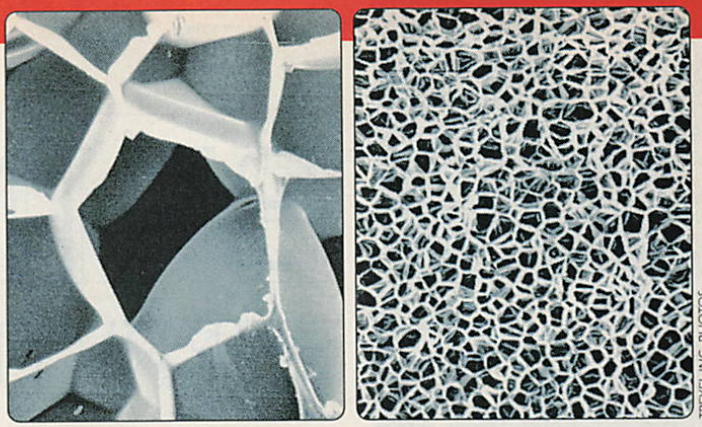
TECH UPDATE

New Commercial Plastics

WOBURN, MA—New plastics that appear solid to the naked eye but are actually foam may soon replace conventional plastics.

The plastics are created using MuCell, a novel microcellular foaming process developed by MIT engineering professor Nam P. Suh. Suh found that he could create foams with ultrasmall cells by replacing conventional "blowing agents" with supercritical fluids of nonflammable atmospheric gases.

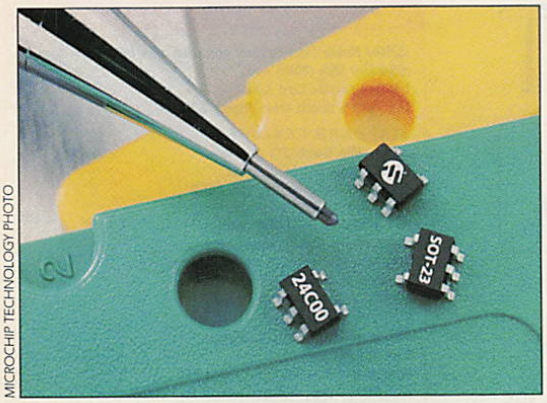
Trexel Inc., based here, and Alusuisse-Lona, of Zurich, say they are now ready to ship commercial quantities of a microcellular polystyrene foam with cells less than 50 microns in size, the first of the new plastics. Trexel President David P. Bernstein says the MuCell polystyrene is stronger and tougher than conventional foams of the same density.



TREXEL INC. PHOTOS

The MuCell process (right) can produce thin sheets of foamed plastic.

Development efforts are now under way to use the MuCell process with other types of polymers.



MICROCHIP TECHNOLOGY PHOTO

MIcrochip Technology's engineers claim the new EEPROM will safely hold data for two centuries.

Tiny Chip Has Long Memory

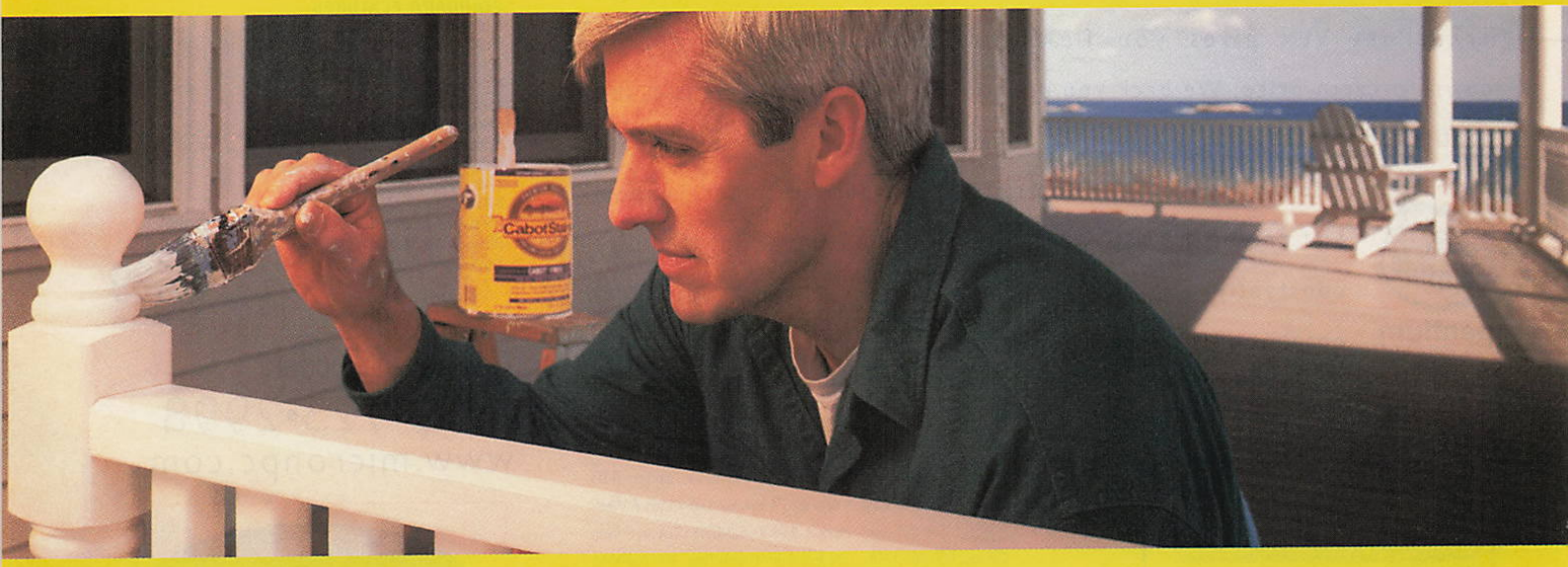
CHANDLER, AZ—An ultrasmall version of a specialized memory chip known as an EEPROM will make it possible to make more products smarter.

Microchip Technology says its new chip is also the world's smallest of its type. Measuring 0.110 × 0.059 × 0.035 in., it takes up less than one-tenth the space of the component it could replace.

An EEPROM is a special type of programmable read-only memory chip that can be electronically erased. Read-only memory chips are typically used to store small computer programs, such as those used by dimmers and thermostats. The electronically erasable characteristic of EEPROMs is useful in a wide range of products, such as keyless-entry systems, in which some of the information must be periodically changed.

Microchip Technology says it has begun shipping design kits so that engineers can begin incorporating the small chip into new products.

Sometimes it's hard to put a label on what helps you feel protected over time.



Long-lasting wood protection has been the singular focus of Cabot Stains since Samuel Cabot invented the very first shingle stain in 1877. Today, Cabot's comprehensive line of interior and exterior wood care products helps homeowners protect their investments with complete confidence.

Fear of disease raised the demand for latex gloves to 9.6 billion a year.

Gloves For The Allergy-Prone

ALBANY, CA—With natural rubber used in more than 40,000 products, allergies to proteins in latex from the Brazilian rubber tree has created both a problem and an opportunity.

The problem is that people who are allergic to the latex can develop symptoms ranging from rashes and hives to life-threatening anaphylactic shock, says Katrina Cornish, of the USDA Agricultural Research Service. Fortunately, she has the solution.

Cornish has developed a procedure to make hypoallergenic latex from the rubber of the guayule (why-YOU-lee) shrub. It is a plant that has been successfully grown in California, Arizona, New Mexico and Texas.

Earlier this year, the latex successfully passed tests at three clinics. The USDA has now granted rights to manufacture products that make use of this process to a Philadelphia-based company. The firm, Yulex, says its first products will be latex gloves.

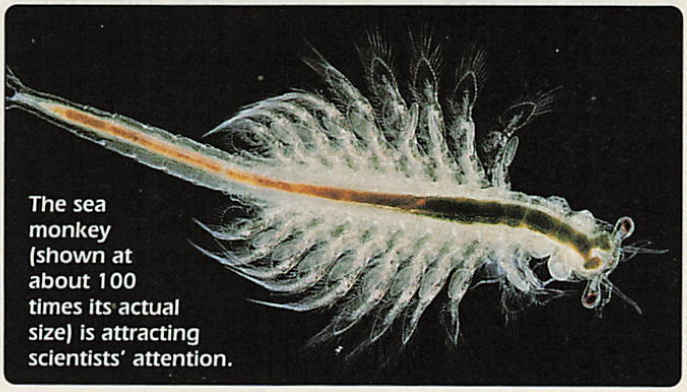
ARS NEWS SERVICE

Sea Monkeys' Immortality

BODEGA BAY, CA—Sea monkeys would make perfect first pets. If the kids forget to take care of them and the water in their tank evaporates, just refill the tank and the tiny critters—which are actually brine shrimp—spring back to life.

Biologists say this is because the shrimp form a protective cyst that enables them to survive if their watery home dries up. Also, using radioactively labeled proteins to study this process, University of California marine biologist James Clegg concluded that shrimp in their cyst stage use absolutely no energy. This upsets one of the foundation stones of biology, which defines a living organism as one that uses energy.

Writing in the *Journal of Experimental Biology*, Clegg says he suspects that a sort of bodyguard compound protects the shrimp by binding to cell protein. He is currently focusing on one promising candidate compound.



The sea monkey (shown at about 100 times its actual size) is attracting scientists' attention.

OXFORD SCIENTIFIC FILMS/ANIMALS ANIMALS/JAL COOKE PHOTO

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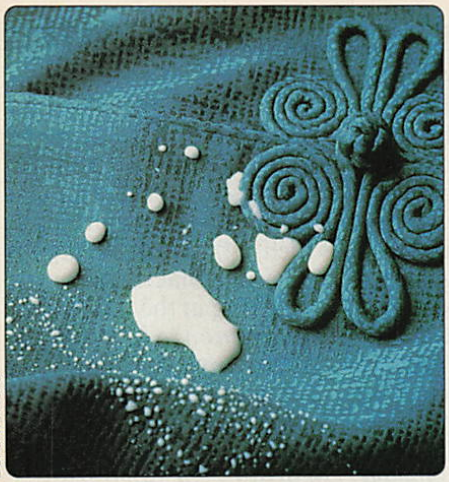


DUPONT PHOTO

Teflon-treated fabrics will make it harder for stains to ruin clothing.

Dressing For A Dirty Job

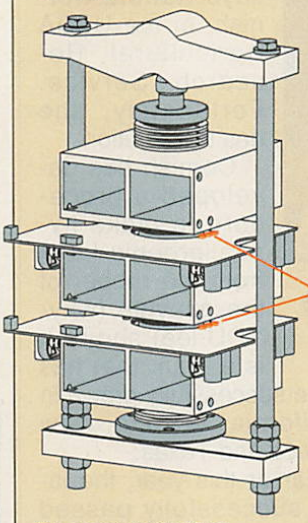
WILMINGTON, DE—Teflon, the material used to make nonstick frying pans, can now be bonded to clothing fibers to make them stain-resistant.

Of course, there are other stain-resistant materials, but they add significant weight or adversely affect the fabric's breathability, feel or appearance. Bonding Teflon to individual fibers appears to avoid these shortcomings, say DuPont engineers.

The process begins at the mill after fibers are dyed and woven into sheets. These lengths of material are then dipped into baths containing a mixture of Teflon and softeners. The Teflon immediately surrounds and bonds to the surface of the individual threads. Excess liquid is squeezed out, and the damp material is then run through a dryer that has a long conveyor belt and is called a tenter frame.

Several clothing manufacturers plan to introduce Teflon clothes in their "casual Friday" collections.

Compact Megawatt Switch



The new switching devices can be stacked to handle higher voltages.

ABB ILLUSTRATION AND PHOTO

NEW BERLIN, WI—ABB Industrial Systems has introduced what it describes as a technology that will make it possible to switch large amounts of electrical power faster and less expensively.

Called an integrated gate commutated thyristor (IGCT), this technology is capable of switching up to 10 megawatts in less than 3 microseconds. The device is constructed from thousands of individual power-switching structures that function in unison. An IGCT switches electrical energy more quickly and dissipates less of the power being switched than gate turn-off thyristors and integrated gate bipolar transistors, the two currently available switching technologies.

Typical control-system applications for the switch, which operates at voltage levels of 2.3, 4.16 and 6.9 kilovolts, include industrial motor drives, traction and ship propulsion and transmission lines, ABB executives told electrical engineers at a recent technical conference.

TOOL TALES No. 3

[REAL STORIES OF *LEATHERMAN® TOOLS* AND THE PEOPLE WHO USE THEM.]

THE TRUCK DIED ON the RHINO TRAIL. AAA was PROBABLY out of The QUESTION.

I was in Rwanda, Africa, providing health care to refugees. A beat-up '68 truck was our only transportation. And my Leatherman Tool was our only tool. It helped us do everything from replacing battery cables to tearing apart brakes. Overall the Leatherman Tool was tough as a wart hog tusk and much more versatile.

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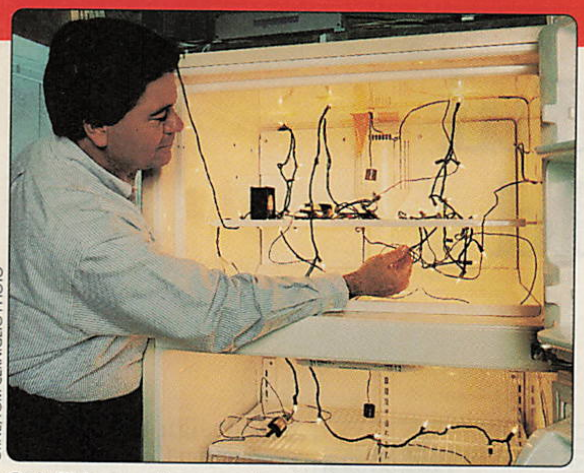


ORNL/TOM CERNIGLIO PHOTO

Oak Ridge engineers estimate that switching to improved refrigerators will save $6.5 billion annually.

Keeping Cool With Old Ideas

OAK RIDGE, TN—Much of the 1-kilowatt-per-day energy savings 21st-century refrigerators are expected to achieve may come from applying three ideas introduced in the early part of this century.

The refrigerator of the future designed by the Department of Energy's Oak Ridge National Laboratory replaces plastic foam insulation with vacuum panels that use the same approach as the classic thermos bottle.

Engineers also traded modern alternating motors, which they say generate too much heat, with cooler direct-current motors.

Lastly, they eliminated the timed defrost cycle that heats up freezer coils daily to remove moisture. Their new "adaptive defrost" takes your grandmother's approach and waits for ice to begin to build up.

Expect to see new refrigerators that take advantage of these old ideas on the market beginning in 2001.

Saving Computer History

BOSTON, MA—The Computer Museum has unveiled a display aimed at keeping upcoming generations of techies in touch with their roots.

They have faithfully recreated a 1970s-era "hacker's garage" to memorialize the multibillion-dollar industry's humble beginnings.

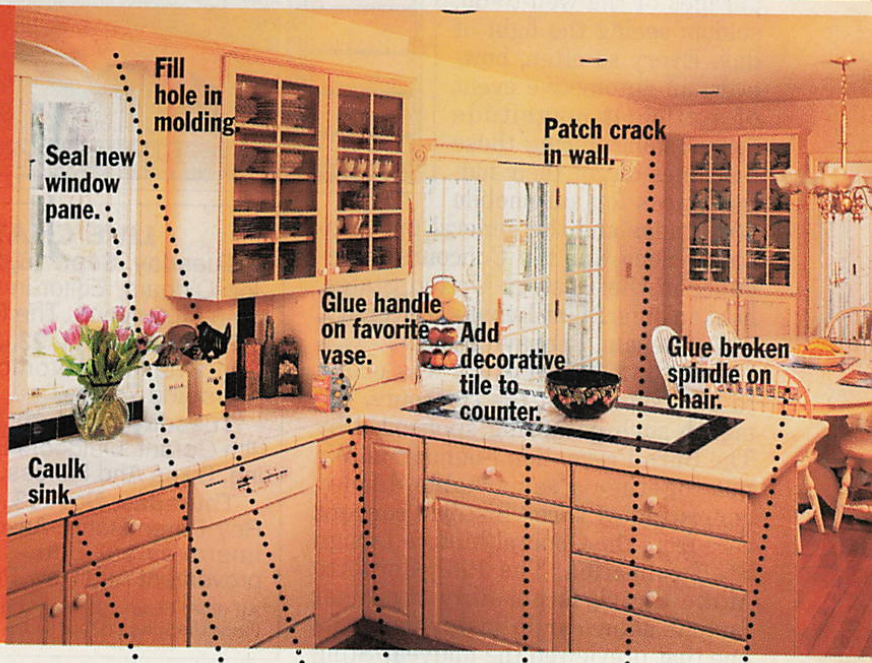
What appears to be a junk-filled garage is actually packed with a collection of future techno-antiques. Among these are an Apple I motherboard designed by Apple co-founder Steve Wozniak and an MITS Altair 8800 created by Ed Roberts. Our friends at the Computer Museum claim that Roberts coined the term "personal computer." The display also includes "Computer Space" and "Pong," the first shots fired in the videogame revolution. The Model 33 teletype that functioned as both a keyboard and printer is also in the exhibit.

THE PRODUCTION NETWORK INC. COURTESY: SOFTBANK/COMDEX PHOTO

What at first glance seems to be junk is really computer history.

Checking to see if any of these valuables are in your garage might be worth the effort of cleaning it.

Elmer's makes the perfect something for practically everything.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No matter where in your house you look, whether it's something you want to do or something you need to fix, Elmer's® has the answer. From glues to wood fillers, caulks to contact cements, Elmer's is the one name you need to know to get the job done right. And get it right the first time. So for your next project or repair, trust Elmer's and you'll get perfect results every time.

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The Most Beautiful Cars In The World

BY CLIFF GROMER, Contributing Editor

At The Car Show

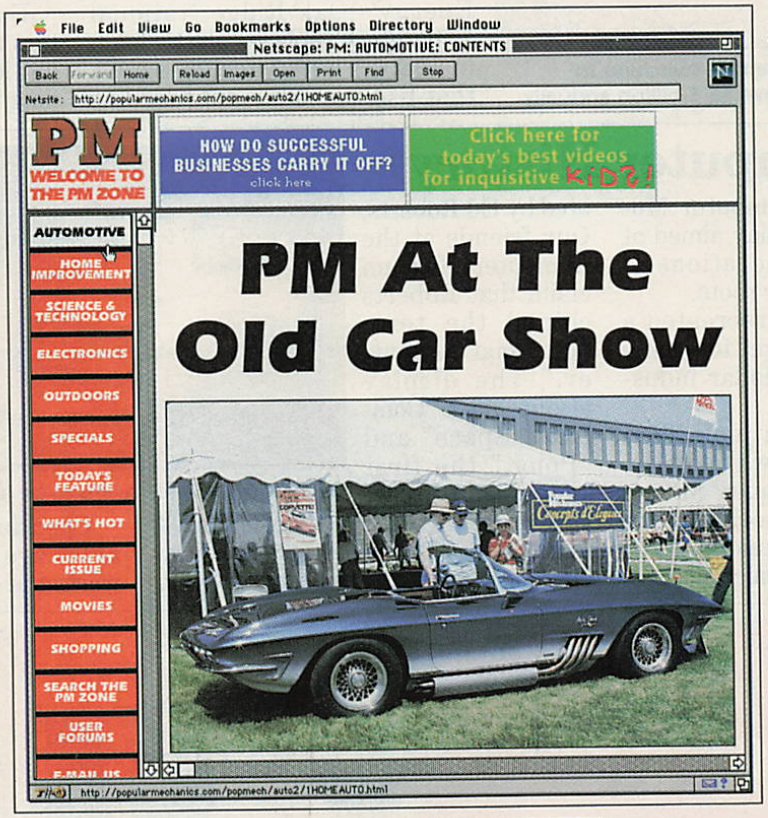
● **Navigation:** *Click on the* Automotive *button on the PMZone menu. Then click on* Collector Cars, *and finally click on* PM At The Old Car Show.

Years ago, automobiles were a far different breed of machine compared to their modern-day counterparts. Elegant, luxurious and large—sometimes very large—the classics bear witness to a legacy of coachbuilding and style that ranks as a high-water mark in motorcar history.

Most classic cars reside in museums or are sequestered in the secured garages of the well-to-do, seldom seeing the light of day. Every so often, however, an automotive event of sufficient magnitude comes along, luring these machines out of their hiding places for automobile aficionados and the general public to enjoy. Such was the Concours d'Elegance of the Eastern United States, held on June 21, at Lehigh University, in Bethlehem, Pennsylvania.

POPULAR MECHANICS was proud to be a sponsor of the Concours, the eighth such gathering sponsored by The Burn Prevention Foundation. We put together a remarkable display consisting of three historic concept cars from the General Motors Design Staff collection. The 1961 Corvette Mako Shark is possibly the most famous show car in history and the one that previewed the midyear Sting Ray design themes that production Corvettes wore from 1963-67. Originally powered by a supercharged small-block V8, it now packs an all-aluminum ZL-1 427 under the hood, and those outside exhaust pipes still make our mouth water.

The other concept cars included in the PM display were the 1938 Buick Y-Job (the first concept car ever) and the 1951 GM LeSabre. Check out the PMZone Web site for complete show coverage.



Live Chats With Our Editors

Navigation: *Click on the* User Forums *button on the PMZone menu. Then click the* Chat *button and follow the directions on the screen.*

We continue our live chats this month (check the PMZone for times) so you can talk one-on-one with editors in three of our departments, and you'll also get a shot at the top man himself—Joe Oldham, Editor-In-Chief.

Don Chaikin, our Automotive Editor, has driven just about everything that's on wheels and loves to talk cars.

Roy Berendsohn, Associate Home Improvement Editor, will discuss remodeling, shop tools and techniques, and lawn and garden tips.

Jim Gorant, our Outdoors Editor, is an expert in boats, motors, snowmobiles, personal watercraft and outdoor clothing and equipment. **PM**

LIVE CHATS

Tuesday, Sept. 16, 2 to 4 pm
Joe Oldham, Editor-in-Chief: "POPULAR MECHANICS, The Magazine."

Tuesday, Sept. 23, 2 to 4 pm
Don Chaikin, Automotive Editor: "Cars And Trucks."

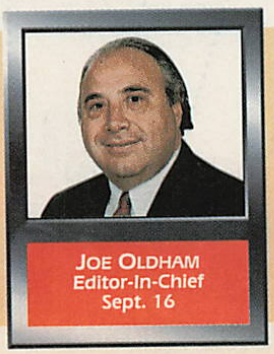
Tuesday, Sept. 30, 2 to 4 pm
Jim Gorant, Outdoors Editor: "Boating, Bikes And Fitness."

Thursday, Nov. 13, 2 to 4 pm
Roy Berendsohn, Associate Home Improvement Editor: "Home Improvement And New Products."

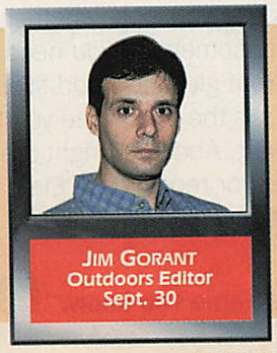
All times Eastern. Dates and times may change. Please check the PMZone for the latest information.

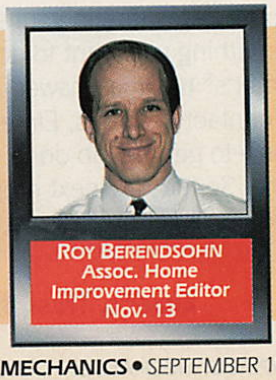
CHAT HOSTS

PM editors will be ready to chat live with you between 2 and 4 pm EST on their assigned dates.


JOE OLDHAM
Editor-In-Chief
Sept. 16

DON CHAIKIN
Automotive Editor
Sept. 23


JIM GORANT
Outdoors Editor
Sept. 30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PM PHOTOS BY CLIFF GROMER

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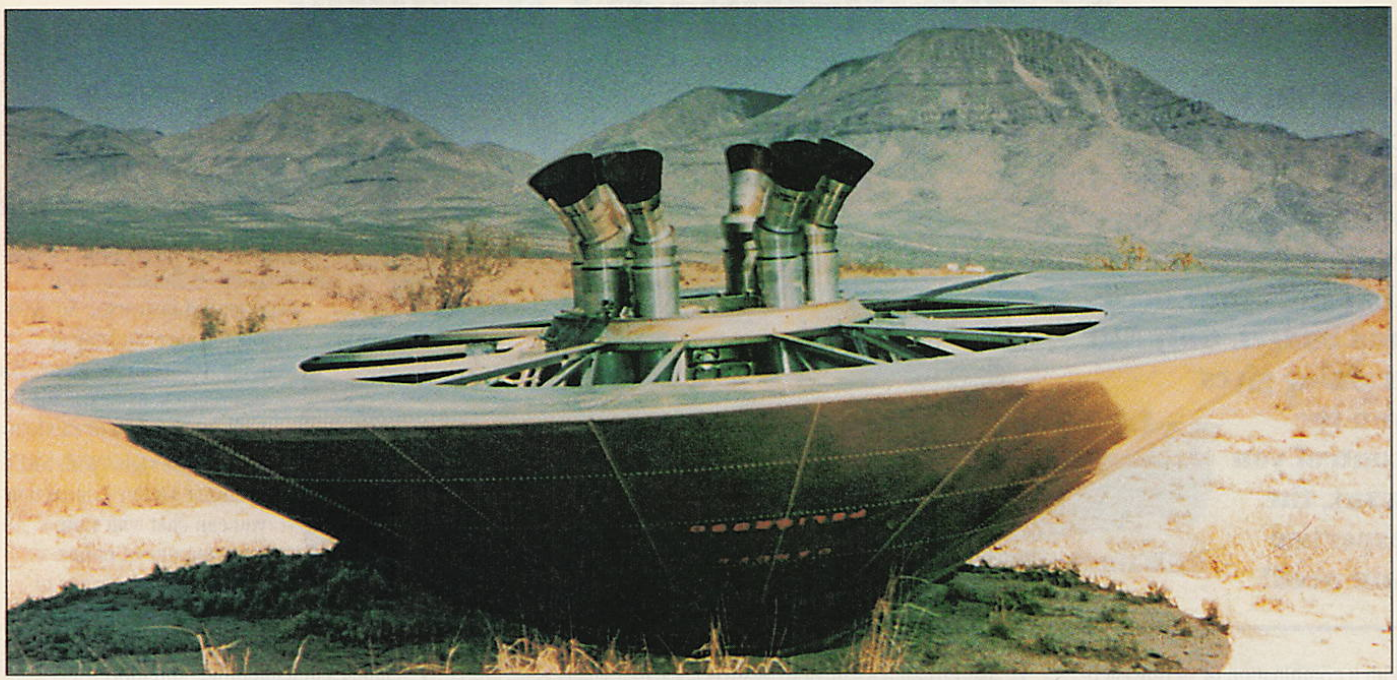
SCIENCE

A Dummy Explanation

BY JIM WILSON, Science/Technology Editor

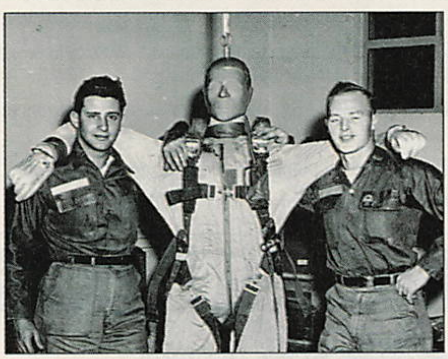


● Since our investigation of the Roswell incident appeared in the July issue, we've heard from several readers who claim to have seen an extraterrestrial (ET). Most say he is a short, green fellow who never meant anyone any harm. A few warned us he is really tall, gray and malevolent. Another reader suggested ET is a time traveler. The hands-down most original description, however, comes from Air Force Capt. James McAndrew. He insists ET's most distinguishing characteristic is a heavy steel eyebolt protruding from his head.

This unusually placed piece of hardware is essential to the government's latest—and fourth, but who's counting—explanation of the so-called Roswell incident. According to those who want to believe the truth is out there, visitors from another planet crashed near Roswell, New Mexico, during the first week of July 1947, and the government has been covering up the event ever since.

McAndrew, who wrote the Air Force study that is supposed to set the record straight, says the members of ET fan clubs have it all wrong. "For the most part, the descriptions collected by UFO theorists were of actual operations and tests carried out by the U.S. Air Force in the 1950s," he said. "When these descriptions were compared to documented Air Force activities, they were much too similar to be a coincidence."

These tests, says McAndrew, became part of Roswell lore because of vivid imaginations and imperfect memories. There was an impolite snickering from the Washington press corps when McAndrew said this at a press conference, but I wasn't among those laughing. This is because I know from firsthand experience how easily the eye can be misled when it comes to unexpected aerial phenomena.



The Voyager-Mars aeroshell (above) and scores of crash dummies fell on the desert in New Mexico during the 1950s and 1960s.

One Moonless night several years ago, I was driving along the narrow country lane that leads to my house. As I rounded a curve, the high beams of my car knifed across a newly mowed field of hay. About 50 ft. ahead, in my backyard, I saw what appeared to be a humanoid figure. It was dressed in a silver suit and moved like an Apollo astronaut enjoying the Moon's reduced gravity.

On closer inspection, the "alien" proved to be a half-dozen Mylar balloons that had escaped from a sweet-sixteen party. After traveling who knows how far, they had too little helium to remain aloft. But there was just enough of the lighter-than-air gas to hold them erect and to allow them to dance in the gentle August breeze. I can understand how a person seeing a crashed "Sierra Sam," as the Air Force dummies were nicknamed, could mistake him for an ET.

Also, the Air Force's insistence that what many believed to be alien wreckage was actually the remains of metal-coated balloons dovetails with our own investigation (see "Roswell Plus 50," page 48, July '97). PM concluded that the "flying disc" that crashed at

U.S. AIR FORCE PHOTOS

Roswell was one of two types of experimental vehicles. Either it was a circular vertical takeoff and landing aircraft based on German designs, or it was a manned version of the Mogul nuclear-test-monitoring balloon that made use of Japanese expertise gained in launching ocean-crossing Fugos. The latter were intended to ignite forest fires in the Pacific Northwest and Canada.

In its latest report, titled "The Roswell Report: Case Closed," the Air Force sticks by its 1994 claim that the Roswell debris was nothing more than the remains of a Mogul balloon. But a close reading suggests there may be more to 1940s-era balloon testing than the government is willing to reveal, even now.

The new report makes specific reference to a robust high-altitude-balloon research effort that included manned projects. In one especially striking passage, McAndrew reveals, "Polyethylene balloons flown by the U.S. Air Force have reached an altitude of 170,000 ft. and lifted payloads of 15,000 pounds."

McAndrew says he obtained this information from the Air Force Phillips Laboratory. PM readers will recall this organization as the research group that is currently developing a military version of the X-33 space plane (see "The New 'Area 51,'" page 54, June '97.)

U.S. AIR FORCE PHOTO

Crash dummies established procedures for human jumps from above 100,000 ft.

Given the Phillips Laboratory's long history in cutting-edge aerospace projects, we were curious about exactly when they began working on these high-altitude, heavy-lift balloons. But this is where the Air Force's report is a little vague. Of the nearly 450 items footnoted in McAndrew's report, two lack the bibliographic citations needed to connect them with original government files that tell the whole story. One omission involves the comment about the Phillips heavy-lift balloon projects. The second piece of incompletely cross-referenced information pertains to Roswell. "From 1947 to the present," the report says, "the Roswell area has been the site of hundreds of balloon and payload recoveries, including those that carried anthropomorphic dummies." But what else besides the Mogul balloons were launched in this era? It would help settle the matter if the Air Force would look at projects by other government agencies that would have used these balloons in their intelligence gathering. Records of the old Atomic Energy Commission (AEC) and the CIA might be a good place to start.

On balance, the Air Force study explains away dozens, perhaps even hundreds, of UFO sightings in the 1950s and 1960s. It also addressed claims about secret alien autopsies, saying the corpses in question were those of airmen killed in the crash of a refueling plane.

As far as further debunking the Roswell episode, McAndrew was less successful. The questions he left unanswered, especially about the role of the Phillips Laboratory, AEC and CIA, make it hard for even a UFO skeptic to accept the report's conclusion that the Roswell episode should be stamped "Case Closed." **PM**

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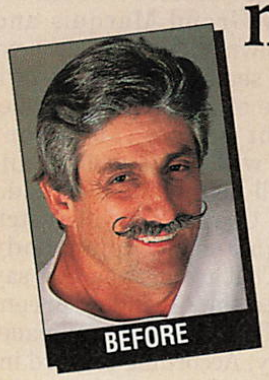

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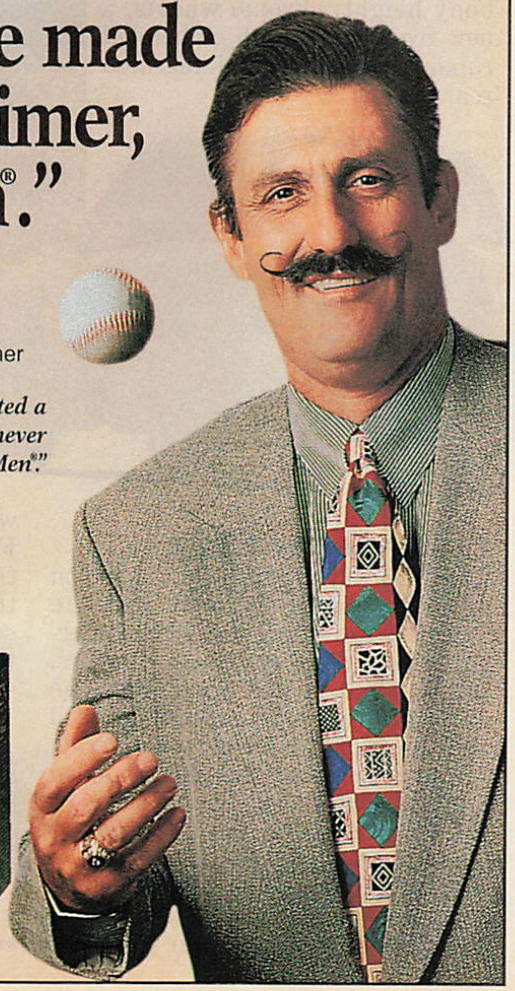

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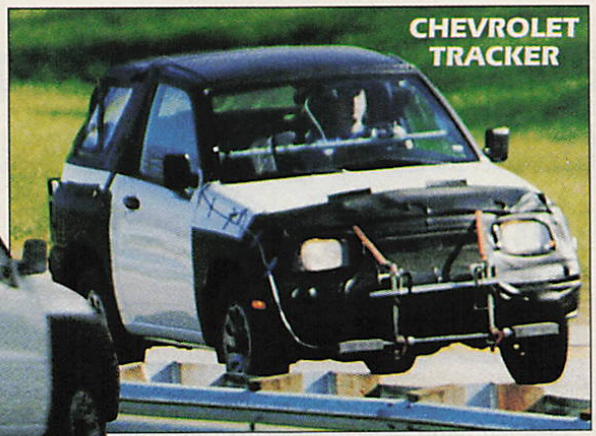
Detroit Spy Report

BY JIM DUNNE, Detroit Editor

'99 FORD F-150

1999 Ford F-150

● A scant three years after its introduction, the best-selling Ford F-150 is getting its face lifted. While the changes to the front end appear minor, they include a new bumper face, a honeycomb-mesh grille insert and a new running-light location. You'll be able to tell a 2-wheel-drive version from a 4-wheel-drive version simply by the grille. Shown here is the 4wd. The 2wd version will have a horizontal bar across the middle of the grille opening, similar in appearance to the new Ranger. Ford's performance version of the F-150, the Lightning, will have unique styling touches, separate from the standard line. Among the special cues are flared rocker panels, lowered body height, chrome wheels, a new front fascia with embedded running lights and an integrated rear bumper.



CHEVROLET TRACKER

Chevrolet Tracker

Chevrolet will unveil this latest version of its compact SUV next fall. The Tracker's exterior is completely different, with a new hood, grille, fenders, doors, windows and bumpers. Gone are the lift slots in the sides of the hood and the front fender blister. Overall, the sheetmetal appears more rounded and the vehicle looks larger. Doors are more conventional in design. The slight dip in the front door ledge is straightened, and the mirrors are set out farther and attached to the door. Door handles appear to be the pull type—in place of the sedanlike flippers. Attachments to the front bumper are merely testing devices, not part of the final design. Remember that Tracker shares virtually all of its parts with the Suzuki Sidekick.

Super-Size Your SUV

Those Chevy and GMC Suburban twins sit at the top of the SUV world, at least in terms of size. But if Ford's and Chrysler's plans come to fruition, Suburban won't hold that seat for long. It's no secret in the industry that Ford plans a 4-wheel-drive passenger version of its F-350 pickup truck. That monster will sport six (count 'em) doors and use Ford's V10 engine as its premium motor. At the same time, the folks at Chrysler have pretty detailed plans for a Dodge Ram-based SUV. Chrysler's model will use a V10 engine—the same engine available in today's biggest Ram pickups. Besides their bigger engines, both of the planned trucks have larger bodies than the current V8-powered Suburban. Look for the Ford super-SUV to hit the market within two years. Chrysler may unveil the mammoth Dodge (Grand Wagoneer?) shortly afterward.

1998½ Crown Vic/ Grand Marquis

Facelifts are in store for both the Mercury Grand Marquis and Ford Crown Victoria early next year. As seen in this photo of a prototype of Marquis, the grille, headlight shapes and front bumper will be revised. Taillights will be modified. In addition, the Crown Vic will switch to Marquis-style upper body panels. That means you can say so long to the 6-window greenhouse, and hello to the wide sail panel of the Mercury. According to Ford insiders, customer demand, along with strong sales to police and taxi fleets, will keep these unique full-size, rear-wheel-drive cars in production for the foreseeable future. PM

'98½ MERCURY GRAND MARQUIS

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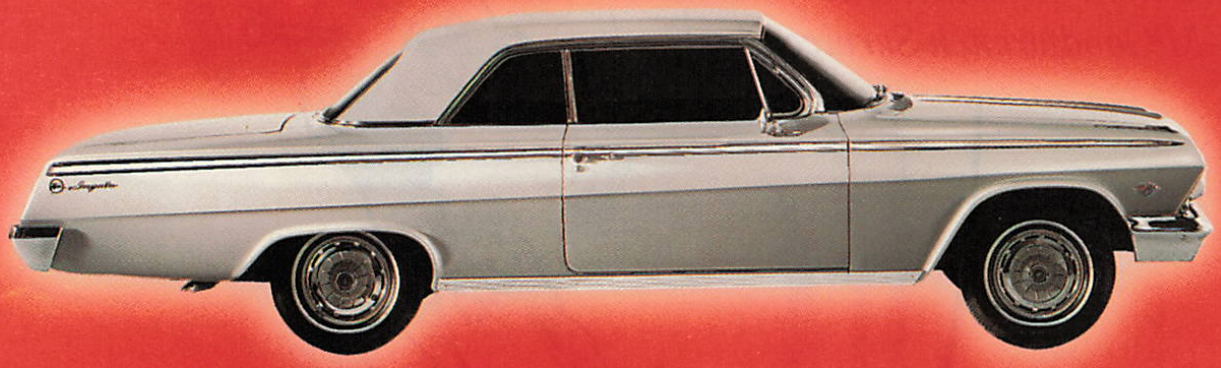

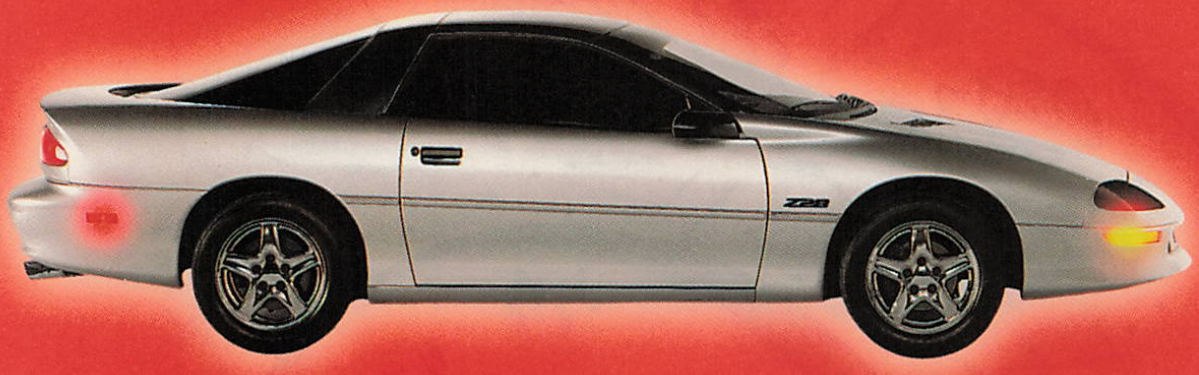

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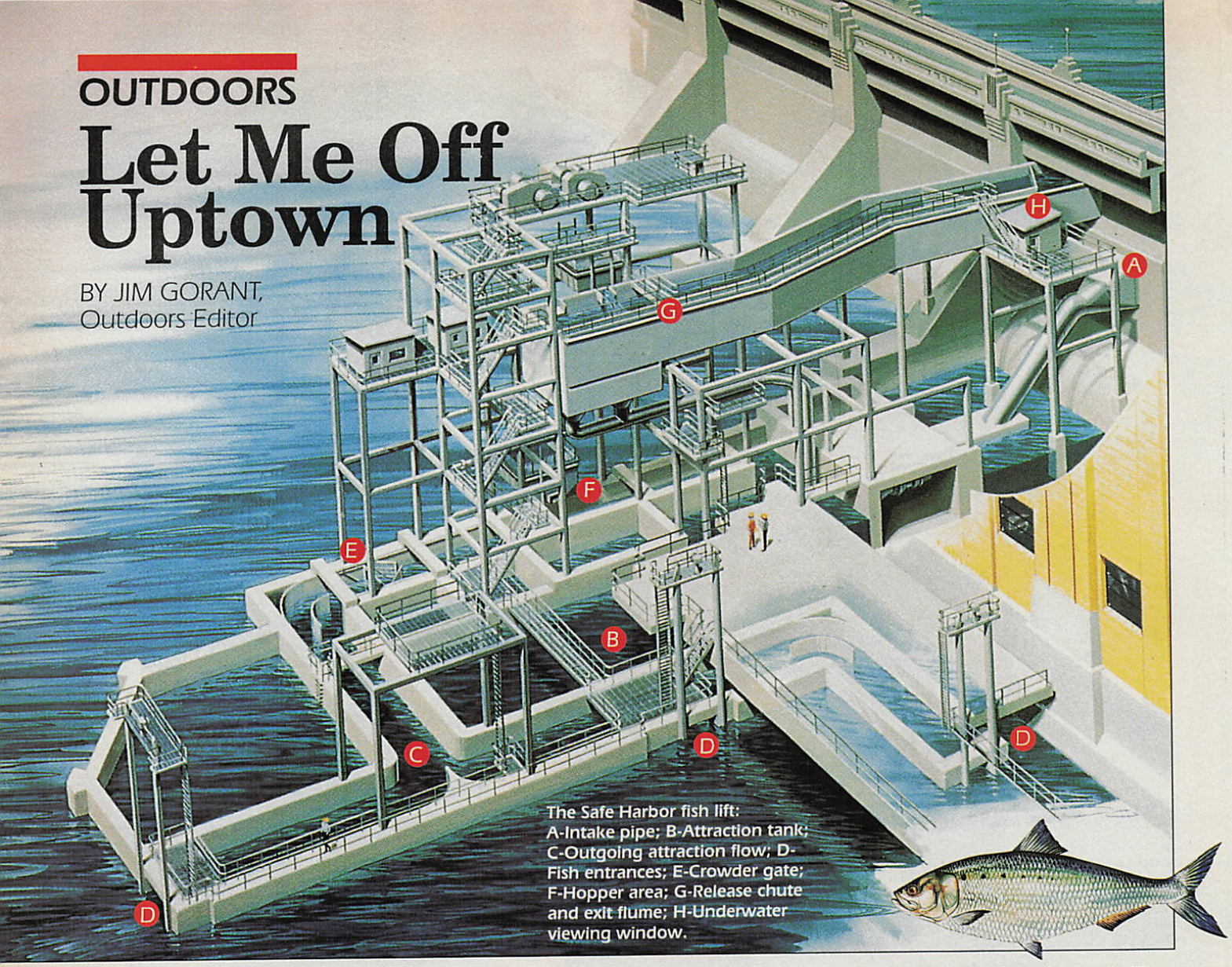
OUTDOORS

Let Me Off Uptown

BY JIM GORANT,
Outdoors Editor



The Safe Harbor fish lift: A-Intake pipe; B-Attraction tank; C-Outgoing attraction flow; D-Fish entrances; E-Crowder gate; F-Hopper area; G-Release chute and exit flume; H-Underwater viewing window.

● After six long, boring speeches, the seventh speaker opens with this: "I feel like Mickey Rooney on the day of his seventh wedding. When someone asked him if he was nervous about his wedding night, Rooney said, 'No, I know what to do, I just don't know if I can make it interesting.'"

If the speech is any indicator, by morning Rooney had yet another disappointed bride on his hands. By the third paragraph, I've given up on speechmakers and wandered off to investigate the real reason a small crowd has gathered along the Susquehanna River. We have all come to Conestoga, Pennsylvania, for the dedication of a brand-new fish lift at the Safe Harbor hydroelectric dam.

From the base of the dam, I watch as a giant hopper filled with dozens of fish rises out of the water. Once the lift reaches the top of the dam, the fish will be released into spawning grounds that have been closed to them for 85 years. I'm thinking, "That's a helluva long time to go without spawning."

Biology

There is something in nature that does not love a wall. On the Susquehanna, the Safe Harbor dam is nothing if not a wall, standing 75 ft. high, 84 ft. wide, and stretching some 5000 ft. across the river. The "something" is the American shad, a native fish that dominated the river for hundreds of years. Like salmon, shad are anadromous, which means they migrate from fresh water to salt water and back. Dams make such journeys impossible.

Under normal circumstances, shad head upriver between early April and mid-June, depending on light, water flow and water temperature. Once they identify their home stream, which they sense using a genetically encoded memory of the exact water chemistry, the females will lay between 200,000 and 300,000 eggs. Only 1 to 10% of those offspring will survive the summer, and in October, when they're about 4 in. long, they'll migrate downstream and out to sea. Three to five years later, at their full-grown size of 4 to 8 pounds, the shad will instinctively return upriver to spawn and die.

In 1896, at the height of the Susquehanna shad fishery, more than 140,000 shad were netted along the river. But between 1904 and 1932, utility companies built the Safe Harbor dam and three other dams—the Connowingo, Holtwood and York Haven—on the lower Susquehanna. Despite the inclusion of rudimentary fish passes, by 1921 the shad had disappeared from the river.

Mechanics

Since around the time Samuel Clemens became Mark Twain, sixth-grade science books and fifth-rate documentarians have been portraying America's rivers as its vascular system, a network of ducts and arteries that transport an essential fluid. If that's the case, then our dams are artery-clogging wads of cholesterol. With four such blockages, the Susquehanna—and its shad—are particularly hard hit.

In the early '70s, when the decision was made to restore shad, administrators executed the fisheries-management equivalent of bypass surgery. Since there were almost no shad that still returned to the Susquehanna, upstream tributaries were stocked with hatchery-raised fry. The returning fish were then trapped below the Connowingo Dam, the southernmost of

PRODUCT SYSTEMS INTERNATIONAL/WHITNEY HARKLEROAD ILLUSTRATION; CHESAPEAKE BAY FOUNDATION ILLUSTRATION (FISH)

the four, and transported upstream by truck. After several false starts, the program eventually took hold, and the number of fish returning to the river jumped from about 300 a year in 1972 through 1984 to more than 60,000 in 1995.

Encouraged by these numbers, the Shad Restoration Partnership initiated the construction of fish lifts at the three lower dams and fish ladders at York Haven. In comparison to the initial effort, these methods were more like angioplasty than full-blown heart surgery. After the Connowingo lift was completed in 1993, Holtwood and Safe Harbor followed suit, and both opened fish lifts earlier this year. The key to their success lies in knowing a lot about the fish.

Shad, like most migratory fish, instinctively know that faster-moving water usually follows the most direct path downstream, so they seek out and swim against the strongest available current. Lift operators can attract fish into the system by providing the appropriate current for them to swim against. On the Susquehanna, the rate of current, or attraction flow, that seems to bring in the most fish is about 5 ft. per second (fps).

In order to control the attraction flow, the Safe Harbor dam has a 72-in. intake pipe on the front, or "bay," side of the dam that funnels water into a large central pool called the attraction tank. The intake pipe has a gate system that can vary the flow from 300 cu. fps to as much as 1000 cu. fps depending on bay elevation, tail-raise elevation and river conditions.

From the attraction tank, water flows out of three open channels into the river at the predetermined rate of 5 fps. Once the fish sense the attraction flow, they follow it into the lift system until they pass through a gate and enter the crowder area. At preset intervals, the gate closes and forces the fish into a small area above the hopper. A 75-hp electric motor raises the hopper 80 ft. on a system of pulleys and cables. With a full load of several hundred fish and 5000 gallons of water, the lift's total payload is about 27 tons.

When it reaches the top, both water and fish are released out a chute into an exit flume, which also has a 5-fps flow rate to keep the fish swimming in the right direction. As the fish exit, a marine biologist stationed at a below-surface window classifies and counts them. The cycle time—or the time it takes the hopper to rise, unload and return—is only 5 minutes, which means it can transport 1.25 million fish during the spawning run, according to the lift's operators.

Paradox

The Safe Harbor dam converts the flow of water into as much as 417,500 kilowatts of power, providing electricity for approximately 167,000 homes. At the same time, the dam interrupts nature's cycles. It keeps fish from their appointed rounds. By slowing the river down, it allows silt to build up, and lets runoff collect, polluting the river and spurring algae growth.

In its attempt to fix some of these problems, the Shad Restoration Partnership has spent $50 million since 1971 trying to cure the problems of technology by creating more technology. But while the fish lifts represent a groundbreaking alliance between government agencies, corporations, and environmental and sportsmen's groups, the preliminary results are mixed. With two weeks left in the spawning season, 62,000 shad had passed through the Connowingo lift, and 24,000 of those had continued on past Holtwood, but only 16,000 of those had gone through Safe Harbor. Officials are hopeful that these numbers will continue to rise, but no one is quite sure of what to do if they don't.

It would be comforting to think that we can make "something" and "wall" a bit more neighborly, but when it comes to man-made boundaries, nature has a way of not giving a damn. **PM**

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Europe Spy Report

BY MIKE ALLEN, Associate Automotive Editor

ALFA ROMEO 166 COUPE

ALFA ROMEO 166 SEDAN

Bravissimo!

● The Alfa Romeo 164—which shares a platform with the Saab 9000—has remained largely unchanged since 1987. Unavailable in the United States for the past few years, the Alfa is being replaced with a completely new family of models that we've identified as the 166. The sedan should appear in Europe in 1999, but the handsome coupe's fate is still uncertain. Powerplants are all V6s, topped by a 270-hp, 3.4-liter biturbo. Biturbo versions will come with a 6-speed manual gearbox and an electronic all-wheel-drive system. Destined to fight for sales against strong competition from the BMW 5-series and Mercedes E-Class, the Alfa 166 may or may not be available on U.S. soil, and not for a year or two after its worldwide introduction—at best. Alfa Romeo hasn't sold *any* new cars in the United States since the 1995 model year, but they do maintain a public relations office and dealerships, so it's still possible that they'll return to selling cars here.

FERRARI F355 REPLACEMENT

Encore, Bravissimo!

No, it's not an F40, but it's the successor to Ferrari's F355, and it's currently code-named F131. This latest offering from Maranello may ultimately be named the F375, or perhaps even Daytona, the latter being a very large pair of shoes to fill. In spite of the strong resemblance to the F40, this car is shorter, on a shorter wheelbase, and has different air intakes and smaller tires. Powered by a 400-hp 5-valves-per-cylinder V8, it should easily see 180 mph in the top gear of its 6-speed gearbox. Due to make its debut this summer, it should go into production in 1999.

Mercedes-Benz C-Class

Though heavily disguised in the rear, their distinctive front styling is very visible. Not to be confused with the in-between redheaded stepchild CLK (built on the current C-Class chassis but with an E-Class drivetrain and looks), the C-Class coupe will be smaller and lighter. An estate wagon and a convertible should also be in the mix when the new millenium begins to roll. Mercedes will be using versions of its new V6s, as well as all-aluminum 16-valve 4-cylinder powerplants. Expect the overall weights of the next-generation C-Class cars to be less, in spite of a longer wheelbase and wider track. Overall size is almost identical to the current car's.

MERCEDES-BENZ C-CLASS SEDAN

MERCEDES-BENZ C-CLASS COUPE

Ugly BMW Duckling

Well, it looks a lot better in the metal than it does in these early official publicity photos. Actually, I saw numerous examples of this car rolling down the production line in BMW's South Carolina factory last spring—but I was sworn to secrecy by the plant manager before entering on other business. Officially, the M Coupe didn't exist then. Reminiscent of the MGB GT, this handsome coupe uses the Z3 chassis and the 240-hp M3 V6, with attendant upgrades to suspension and brakes. We'll see it sometime after the introduction of the M Roadster. The drop-top uses M3 power and is recognizable only by its slightly flared fenders, wider wheels and tires and Motorsports badging. Unofficially, production of the M Roadster may begin anytime, and the M Coupe should follow six to twelve months after that. PM

BMW M COUPE

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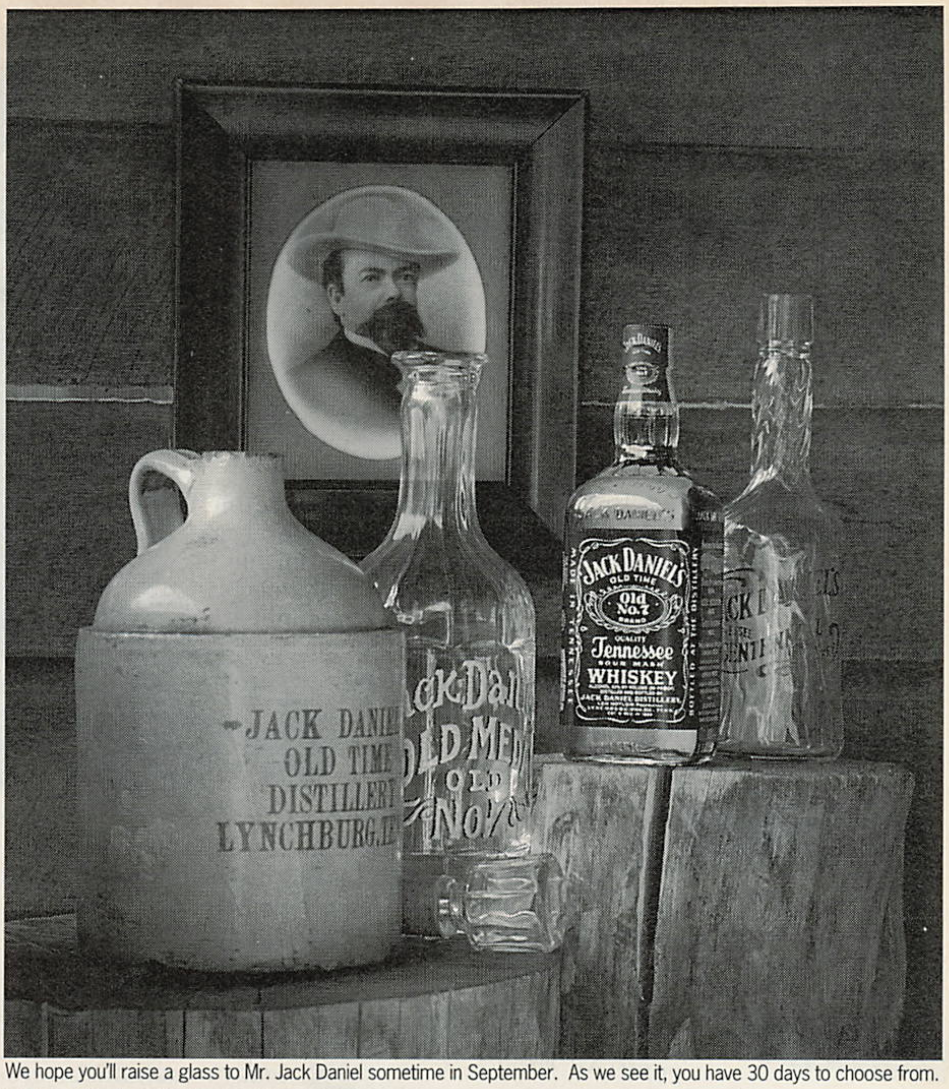

We hope you'll raise a glass to Mr. Jack Daniel sometime in September. As we see it, you have 30 days to choose from.

THIS SEPTEMBER marks Mr. Jack Daniel's 151st birthday. Or maybe, as some say, his 147th.

The exact date of our founder's birth remains a mystery to this day (folks weren't too good at keeping records in those days). Some in Lynchburg say he was born in 1850, others claim it was 1846. While no one is exactly sure just when Mr. Jack was born, those who enjoy a smooth sippin' Tennessee Whiskey, we believe, are mighty glad he was.

SMOOTH SIPPIN' TENNESSEE WHISKEY

Your friends at Jack Daniel's remind you to drink responsibly.

Tennessee Whiskey • 40-43% alcohol by volume (80-86 proof) • Distilled and Bottled by Jack Daniel Distillery, Lem Motlow, Proprietor, Route 1, Lynchburg (Pop 361), Tennessee 37352

Placed in the National Register of Historic Places by the United States Government.

Think It's New? Think Again!

Nine decades of inline skates.

BY MARY SEELHORST

PRESENT • Bombed a hill on a pair of inline skates lately? Once marketed merely as safe exercise, inline skates have shot a 360 from amiable to aggressive in the past few years. Today's skates put a new edge on hockey, challenge skateboarders' stunts and defeat city traffic with street-smart swish. Rollerblade, the Kleenex of inline skates, even has a Web site with hot links to sites for inline skate events from Holland to Brazil.

Yes, inline is definitely in.

PAST Think it's new? Think again! PM was advertising a revolution in roller skates as early as 1910. Poodle skirts weren't even invented yet, and already, 4-wheeled parallel skates were labeled old-fashioned by the Kennedy Skate Co. of Chicago. Of course, the 2-wheeled Kennedy promised the same comfort, durability and light weight as today's skates. And what about those high-performance alloys today's manufacturers brag about? They have nothing on the Kennedy. Wheels made of "a special alloy of aluminum and bronze . . . cling to the smoothest floor." And a street skater could take comfort in the knowledge that the "direct-action rubber cushion" made the Kennedy "an ideal pavement skate."

December 1910

POPULAR MECHANICS ADVE

160

ROLLER SKATING Revolutionized

You have never known the **real joy** of roller skating until you have skimmed away on a pair of KENNEDY'S. **Such perfect ease of motion**, such a **delightful sense of security**, such **absolute perfection of pleasure!** Beginners skate **better** on their **first attempt** with KENNEDY'S than **after weeks of effort to master old-fashioned "four wheelers."**

Price **$5.00**

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1. **Light, rigid, comfortable, inconspicuous ankle brace,** permitting of exactly the same movement as the ankle itself, but absolutely preventing all chance of side movement or "wobbling."
2. **One-half number of wheels and bearings**—ball bearings throughout—wheels double the size of four wheeled type. **Friction practically eliminated. Speediest skate ever made.**
3. **Movement and balance exactly the same as in ice skating.** Movable, spring controlled front wheel enables you to skate any kind of a curved stroke **without lifting skate from the floor or disturbing the balance.**
4. **Direct action rubber cushion** eliminating all jar and making it an ideal pavement as well as rink skate.
5. **Wheel tires a special alloy** of aluminum and bronze—immensely tougher than the ordinary cast aluminum wheels and which **clings to the smoothest floor** better than any other material.
6. **Absolute binding guarantee** against any defect of material or workmanship.

ON TRIAL—We want you to actually try a pair of KENNEDY'S at **our risk.** If you are not convinced after the very first trial that they are even better than we say, return them at once. WRITE NOW for **free booklet.** Post yourself at once on the greatest invention in the history of skating.

KENNEDY SKATE CO., Dept. 1199, 310 W. Indiana St., CHICAGO, ILL.

Motors and Dynamos

We offer for sale New Standard Western Electric

But what's in it for the aggressive skater? "Friction practically eliminated. Speediest skate ever made," the ad promised—not to mention the "light, rigid, comfortable, inconspicuous ankle brace." (Roller hockey, however, is not mentioned.)

If figure skating with inlines is what tickles your toes, you might have had to wait until 1950, when PM promoted "Figure Skating With Roller Skates." These skates made in Japan had three inline wheels and a clever ratchet gear that kept the front wheel from turning backward during quick turns. Today, Kristi Yamaguchi endorses a skate with a brake on the front for action similar to figure skates. Is nothing new?

Present-day folklore has it that hockey player Scott Olson cobbled together a pair of 'blades in 1979 in his parent's basement, starting the inline revolution. More than 200 million people now strap on inlines for sports and exercise. The concept just never caught on in 1910, or in 1950. Perhaps the alloys just weren't good enough. Or traffic wasn't bad enough. Or there wasn't a Kristi to endorse them. And maybe there was a stack of old POPULAR MECHANICS somewhere in the dark corners of the Olson basement. **PM**

April 1950

DISH NETWORK DOES IT AGAIN!

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NO UPFRONT ANNUAL SUBSCRIPTION!

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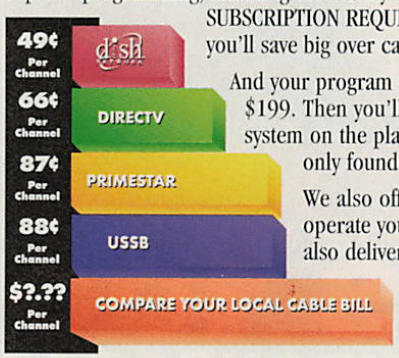

Per channel cost based on published prices as of 5/9/97.

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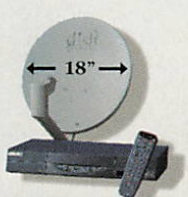

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Premium movie services are also available in a multichannel format including HBO/HBO Family (6 channels), Cinemax (3 channels), Showtime (3 channels), The Movie Channel (2 channels), FLIX and Sundance Channel — all at incredibly low prices! So if you're tired of cable constantly raising your rates and want more versatility, more choices, more service and definitely more value, call DISH Network today!

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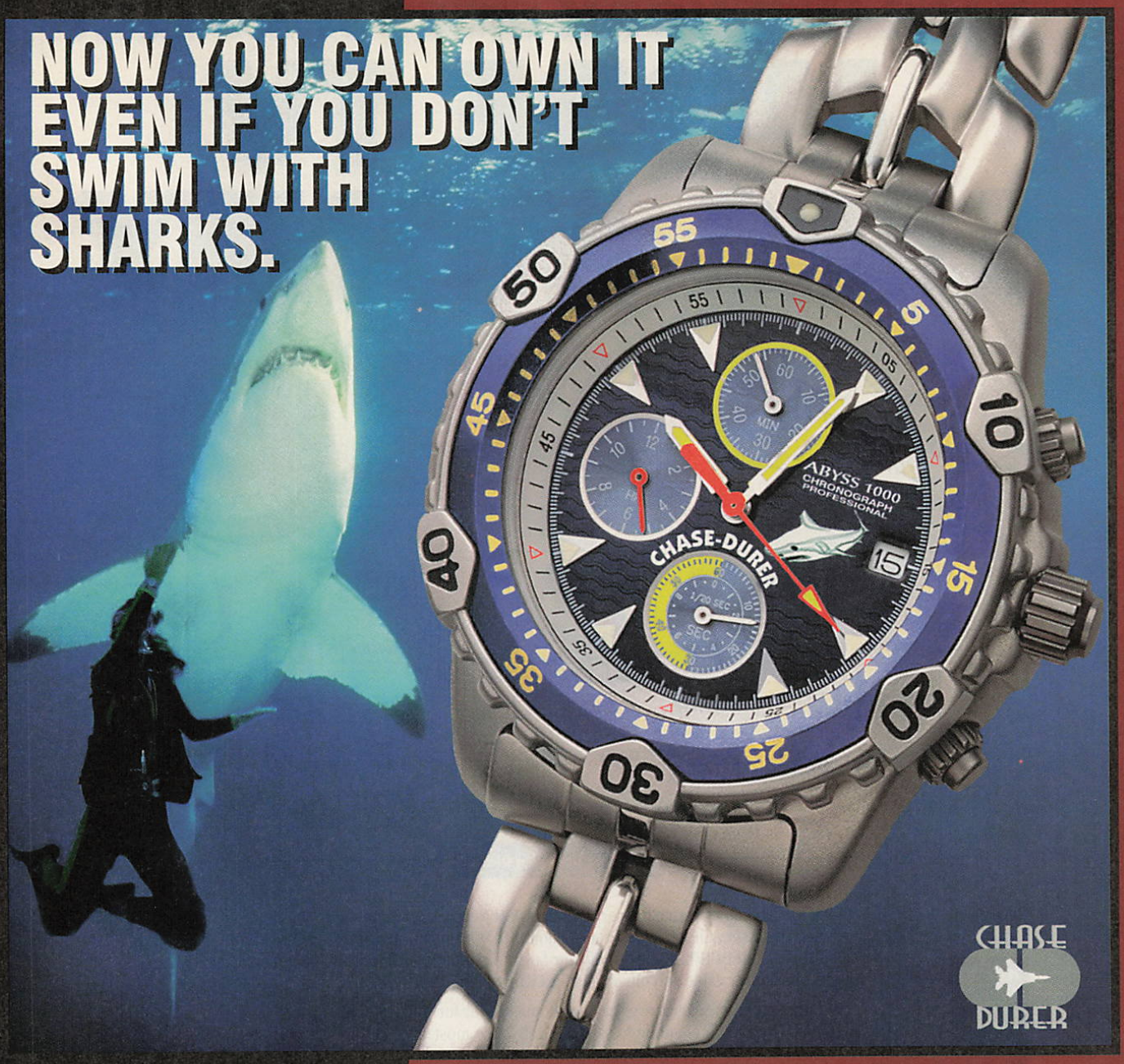

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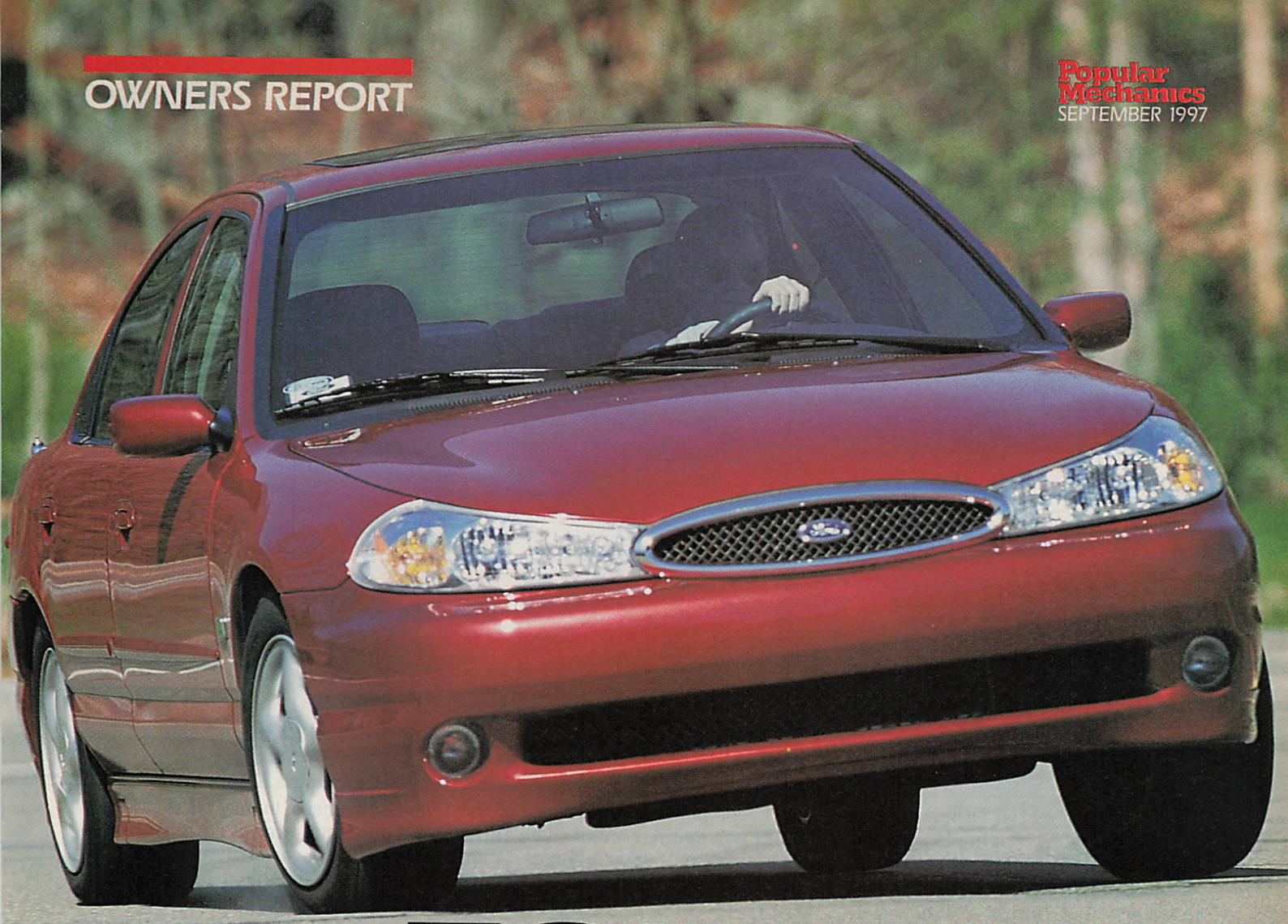


FORD CONTOUR

Ford's "world car" is proving to be up to the challenges.

BY MICHAEL LAMM, Contributing Editor

● Ford took a $6 billion gamble when it introduced its Contour and Mystique sedans, near-twins that are offspring of Ford's European sedan, the Mondeo. The big-money question is: Can a European-designed and -engineered car succeed on the American market?

Ford's Mondeo was developed in Europe and went on sale there in late 1993. It sold very well from the start and immediately won enough European car-of-the-year honors to fill a showcase. Ford North America waited one year to work out the bugs, but there weren't any to speak of. Then, in September 1994, Ford launched both domestic versions of the Mondeo. And while the Ford Contour and Mercury Mystique have gotten generally good press in this country, the public's response has not been overwhelming. Combined sales last year for the Contour and Mystique were about half that of their larger sisters, Taurus and Sable.

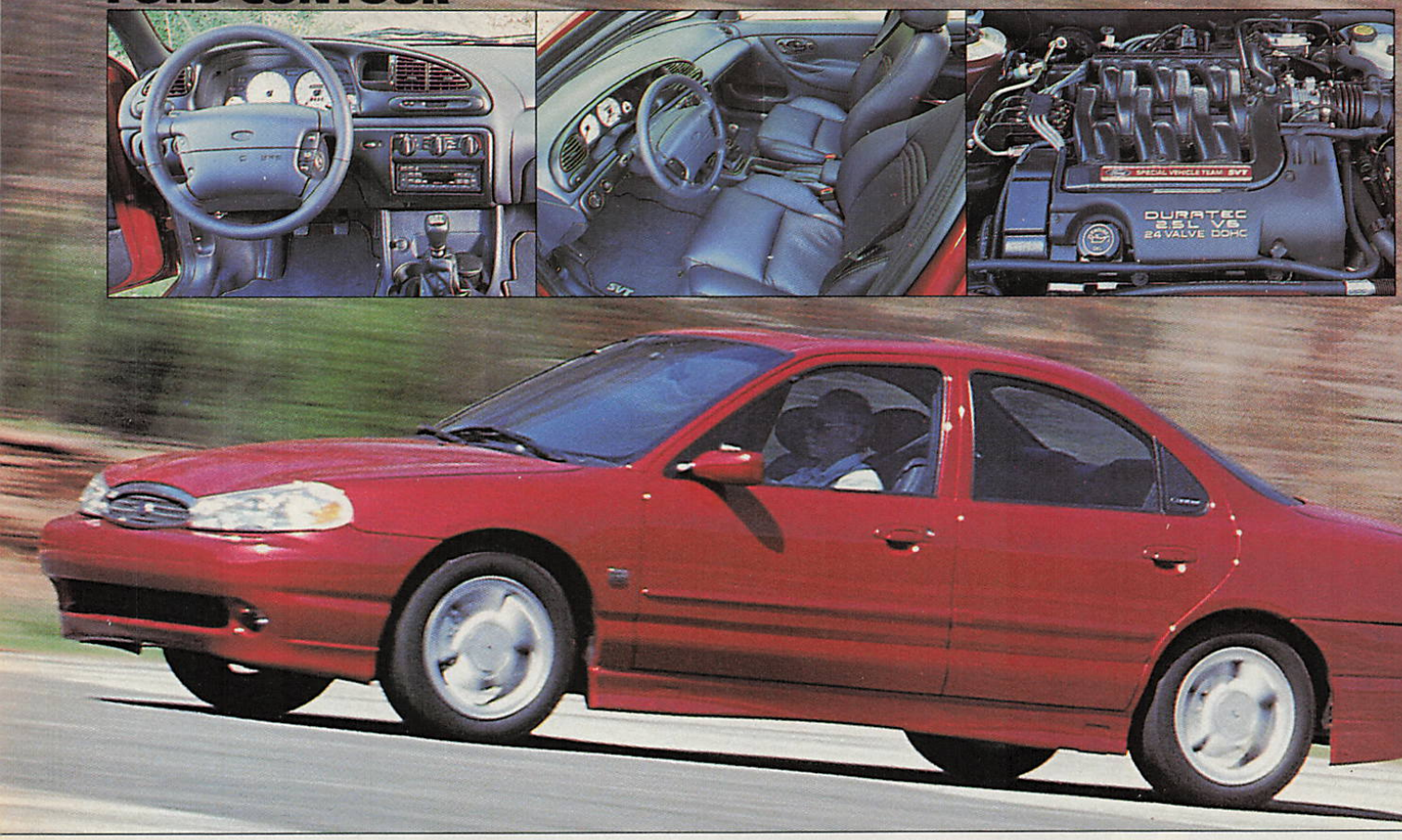
While the Contour and Mystique differ cosmetically, they're mechanically identical. So for the purposes of this report, we'll focus on the Contour, which outsells its Mercury sibling by more than three to one.

The Contour is powered by either Ford's 2.0-liter Zetec Four or the 2.5-liter Duratec V6. Both of these all-new powerplants have dual overhead cams and four valves per cylinder. The Four delivers 125 horsepower, which in a 2760-pound car gives respectable performance and good fuel economy. However, better performance comes in the form of the 170-hp V6 engine, which develops 165 ft.-lb. of torque.

Ford emphasizes that the V6 needs no tuneup for 100,000 miles, at which point the platinum-tipped spark plugs should be replaced.

The V6 engine is available on Contour SE models, which also brings firmer shock settings, wider tires and 4-wheel disc brakes. Other models have drums in the rear. Regardless of the model, antilock brakes with traction control are optional. Also on the options list is

PM PHOTO BY BILL ERDMAN



a 4-speed automatic. Otherwise, regardless of which engine is selected, the Contour SE comes with a 5-speed manual, making it one of the few cars in its segment that is available with the sporty V6 and 5-speed drivetrain.

Standard equipment on all series includes a MicronAir filtration system that keeps pollen and dust out of the passenger compartment. The filter traps airborne particles bigger than 3 microns, and a number of buyers with respiratory problems said that this was an important consideration in their purchase. Ordinarily, such filtration systems are available only in more expensive luxury-class cars.

Additional standard features include a cross-car structural brace between the windshield pillars, boron-steel side beams, dual airbags, power steering and brakes, remote releases for trunk and fuel door, AM/FM stereo radio, variable intermittent

SUMMARY OF FORD CONTOUR OWNERS REPORTS*

Total miles driven	**1,216,959**
Average miles driven	**6682**
Purchase price:	
Average	$17,182
Range	$13,500-$22,000
Model choices:	
Mercury Mystique GS	27.3%
Ford Contour GL	25.2
Mercury Mystique LS	23.3
Ford Contour LX	14.0
Ford Contour SE	10.2
Engine choices:	
2.5-liter V6	51.4%
2.0-liter Four	48.6
Transmission choices:	
4-speed automatic	79.1%
5-speed manual	20.9
Options/Accessories:	
Air conditioning	99.7%
Cruise control	92.7
Power door locks	88.8
Power windows	84.8
Antilock brakes	62.6
Alloy wheels	59.6
Premium sound system	54.5
Traction control	50.5
Power seats	46.3
Keyless entry	45.7
Power moonroof	18.5
Why did you choose the Contour/Mystique?	
Styling	57.5%
Price/value	26.3
Standard equipment	14.0
Handling	12.3
Power and performance	10.2
Safety features	8.9
Previously owned a Ford or Mercury product	7.5
Economy and fuel mileage	6.8
Avg. mpg, city/hwy:	
2.0-liter automatic	24.5/30.7
2.0-liter manual	27.8/33.4
2.5-liter automatic	21.6/26.7
2.5-liter manual	23.6/27.4
Specific likes:	
Handling	58.5%
Styling	49.1
Power and performance	35.6
Comfort	25.3
Economy of operation	17.0
Ride quality	14.9
Colors	9.7
Vehicle size	9.3
Specific dislikes:	
No tilt wheel available	15.6%
Noise at highway speeds	9.5
No complaints	9.1
Location of door locks	8.2
Weak/poor cup holders	7.8
Not enough interior room	7.4
Rear-seat legroom	6.5
Suggested changes:	
Add tilt wheel	21.0%
Better cup holders	8.1
More roomy interior	7.6
No changes	7.1
Increased quietness	6.7
Reposition power door locks	5.7
Redo seat adjusters	5.7
Engine power:	
Excellent	66.3%
Good	30.1
Fair	3.3
Poor	0.3
Handling:	
Excellent	75.4%
Good	22.5
Fair	1.5
Poor	0.6
Braking:	
Excellent	72.5%
Good	27.2
Fair	0.3
Poor	0.0
Overall performance:	
Excellent	72.2%
Good	26.6
Fair	0.9
Poor	0.3
Layout of controls:	
Excellent	58.8%
Good	37.8
Fair	2.4
Poor	0.9
Driver sightlines:	
Excellent	61.3%
Good	35.2
Fair	3.1
Poor	0.6
Overall convenience:	
Excellent	58.9%
Good	39.8
Fair	1.0
Poor	0.3
Workmanship opinion:	
Excellent	62.0%
Good	35.9
Fair	1.8
Poor	0.3
Front-seat comfort:	
Excellent	62.5%
Good	31.8
Fair	2.1
Poor	0.9
Rear-seat comfort:	
Excellent	31.3%
Good	47.0
Fair	19.1
Poor	2.6
Any mechanical trouble?	
No	63.3%
Yes	36.7
What type of trouble?	
Car noises	10.7%
Transmission	10.7
Poor paint quality	6.6
Shoulder harness retractor	6.6
Power door locks	5.8
Engine starting problems	5.8
Repair it yourself?	
No	97.5%
Yes	2.5
Dealer repairs satisfactory?	
Yes	73.2%
No	26.8
Dealer service opinion:	
Excellent	52.8%
Good	38.0
Fair	7.4
Poor	2.9
Dealer sales policy:	
Excellent	54.8%
Good	35.4
Fair	7.3
Poor	2.5
Number of vehicles owned:	
This vehicle only	28.4%
Two vehicles	48.5
Three vehicles	16.2
Four or more	6.9
Principal driver:	
Female	58.4%
Male	31.2
Both equally	10.4
Age distribution of owners:	
Under 30	15.6%
30-49	65.6
50-plus	18.8
Based on your experiences, would you buy a Contour or Mystique if you had it to do over again?	
Yes	66.0%
Maybe	27.7
No	6.4

* Percentages might not equal 100% due to rounding or insufficient data.

PM PHOTOS BY CLIFF GROMER (INSETS) AND BILL ERDMAN (BACKGROUND)

wipers, a console with cup holders and reclining front bucket seats. The 60/40-split rear seatback folds forward in all series except the Contour GL and has a built-in armrest.

One item that 15.6% of our owners missed was an adjustable steering column. Ford promised a tilt wheel as standard equipment in early announcements, but the company wasn't able to deliver it in early versions of the car because of incompatibility with the driver's-side airbag.

Owners of Contours and Mystiques reported very few mechanical problems. The most common centered on the two transaxles. The 5-speed was hard to shift in freezing weather due to the high viscosity of the gear oil. And the automatic sometimes jerked between shifts, in which case most dealers simply replaced it under Ford's 3-year/36,000-mile warranty.

While critics found the Contour short of rear-seat legroom, owners seemed to mind this less than our auto editors. While we did hear some grumbles, only 6.5% of our respondents listed tight legroom as a specific complaint. Others called both rear legroom and headroom "marginal." Some suggested taking space from the trunk—which everyone agreed was generously large—and applying 4 in. or so to the rear's floor length. Ford opted instead to change the configuration of the rear-seat cushion and the shape of the backs of the front seats to add about 2 in. to rear legroom in the latest versions of the Contour.

Other recommended changes included moving the power lock switch away from the door handle because several drivers locked themselves out. A few suggested adding more sound insulation to dampen road and engine noise, switching from rowel-type seat adjusters to levers, engineering stronger and wider cup holders and making both windshield wipers the same length.

Our owners gave the car excellent marks on styling, with roughly half of our surveyees praising the Contour's contemporary oval-on-oval front-end theme. Mystique owners told us they favor their cars' more Mercury-esque grille and conventional design cues.

But it was handling that really brought down the house. "Excellent handling, especially on snowy, icy roads," said a Maryland nurse. "Traction control with ABS gives most of the benefits of 4wd without the cost, weight and maintenance."

Basically, most of the owners we queried found their Contours to be comfortable, practical, economical and troublefree. "Probably the best all-around car I've ever owned," stated a Florida construction supervisor. **PM**

EDITORS REPORT

Curvaceously Wrapped Enigma

● It seems that each time we climb behind the wheel of a different Contour, we come away with a different impression about the car. For instance, in our recent comparison test of like-priced and like-sized sedans (see "Family Fun," page 44, April '97), we were essentially underwhelmed with the performance of the V6 and 4-speed automatic drivetrain. But when we spent a full year and more than 15,000 miles with a different Contour SE, we found that our logbook was filled with nothing but praise for its V6 engine and perfectly mated 5-speed manual.

Hey, wait a minute, maybe we're onto something here.

Given Ford's original game plan with the Contour—taking what was essentially a European interpretation of a small family sedan and adapting it to the U.S. market—the different impressions of the different versions of the car are not so surprising.

In fact, if you're the kind of person who wants a sporty, European-flavored sedan, but whose disposable income prevents you from getting past the front door of the local BMW dealership, the Contour may be just what you want. It's one of the few 4-door cars around—at any price—that lets you shift gears totally for yourself. And when you opt to do that while spinning those gears via the V6 engine, the fun meter is pegged. But if you want a BMW—or Volkswagen or even Maxima—kind of performance from a Contour with any of the other available powertrain combos, you may find the V6's 165 ft.-lb. of torque wanting. At least we did in the aforementioned comparison test.

What we've never found wanting in any Contour, regardless of the model, is crisp handling. Here, Ford's engineers did an exemplary job of adapting the finest traits of Europe's finest-handling sport sedans and bestowing them on the Contour. The car is nimble and responsive. But that didn't stop those fun fellows at Ford from giving it the SVT treatment for truly superior handling.

However, regardless of the enjoyment you may have from the driver's seat of a properly equipped Contour, you probably won't receive the same kind of pleasure while sitting in the back. Despite Ford's various attempts at squeezing a couple more inches of rear-passenger space into the package, there's no denying that the Contour feels small inside. That's because the Contour *is* small inside. Two full-size adults in front are apt to brush shoulders, and on long drives they may fight for some elbowroom. Taller drivers are going to long for both more headroom and legroom.

Nevertheless, Ford has done a fine job of stuffing that snug interior with good things. Every Contour comes with a solid-particle filter in the ventilation system, which is a real boon during hay fever season. Of course, some of the features boast some screwy ergonomics—like door-lock buttons that look as if they're unlocked when they're actually locked.

But if you drive alone, or with rear passengers who have yet to see the inside of a junior high school, the properly motivated Ford Contour and near-twin Mercury Mystique represent one heck of an affordable sport sedan. *—Don Chaikin*

PM PHOTOS BY CLIFF GROMER

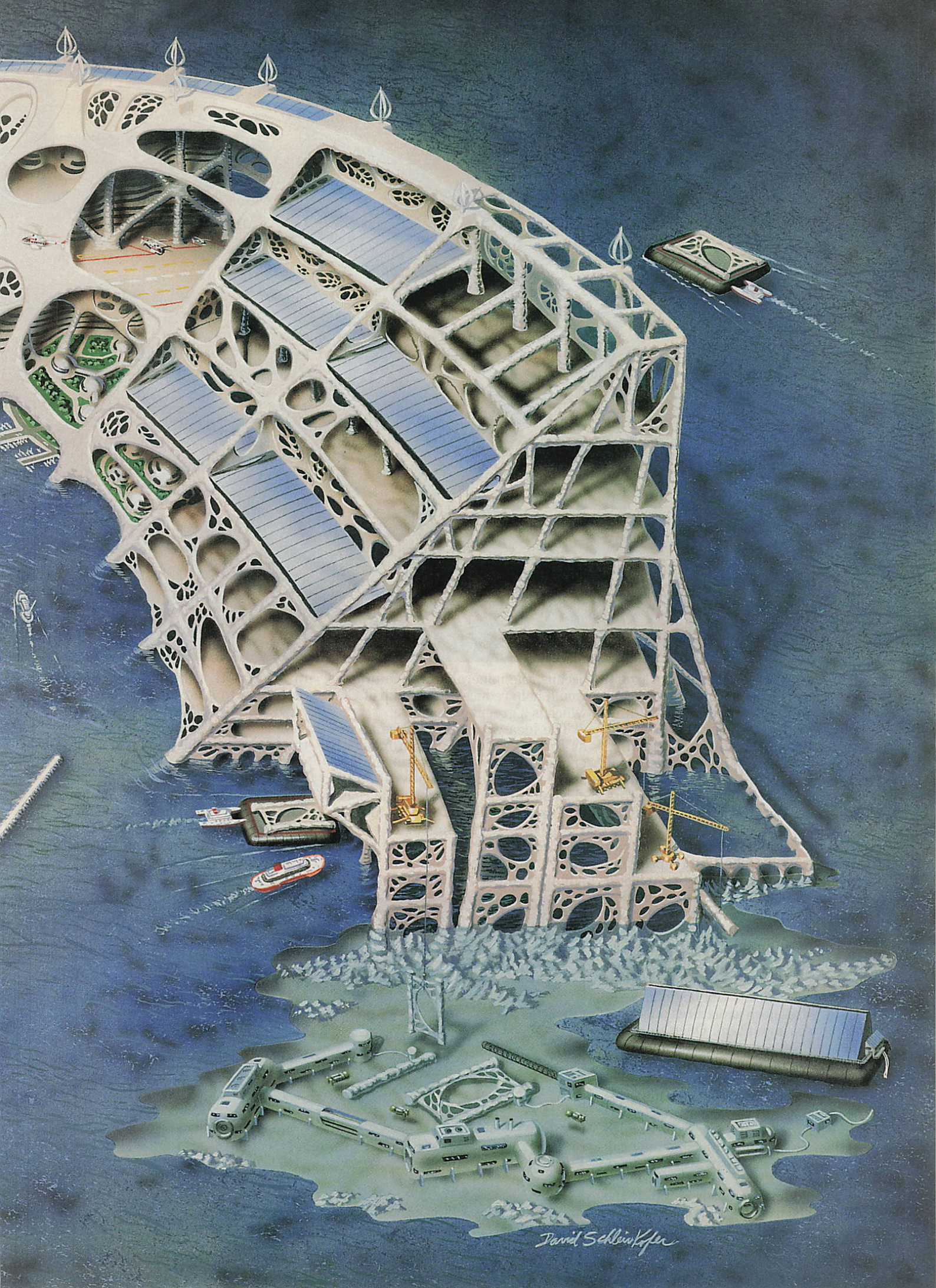
OCEAN-GROWN HOMES

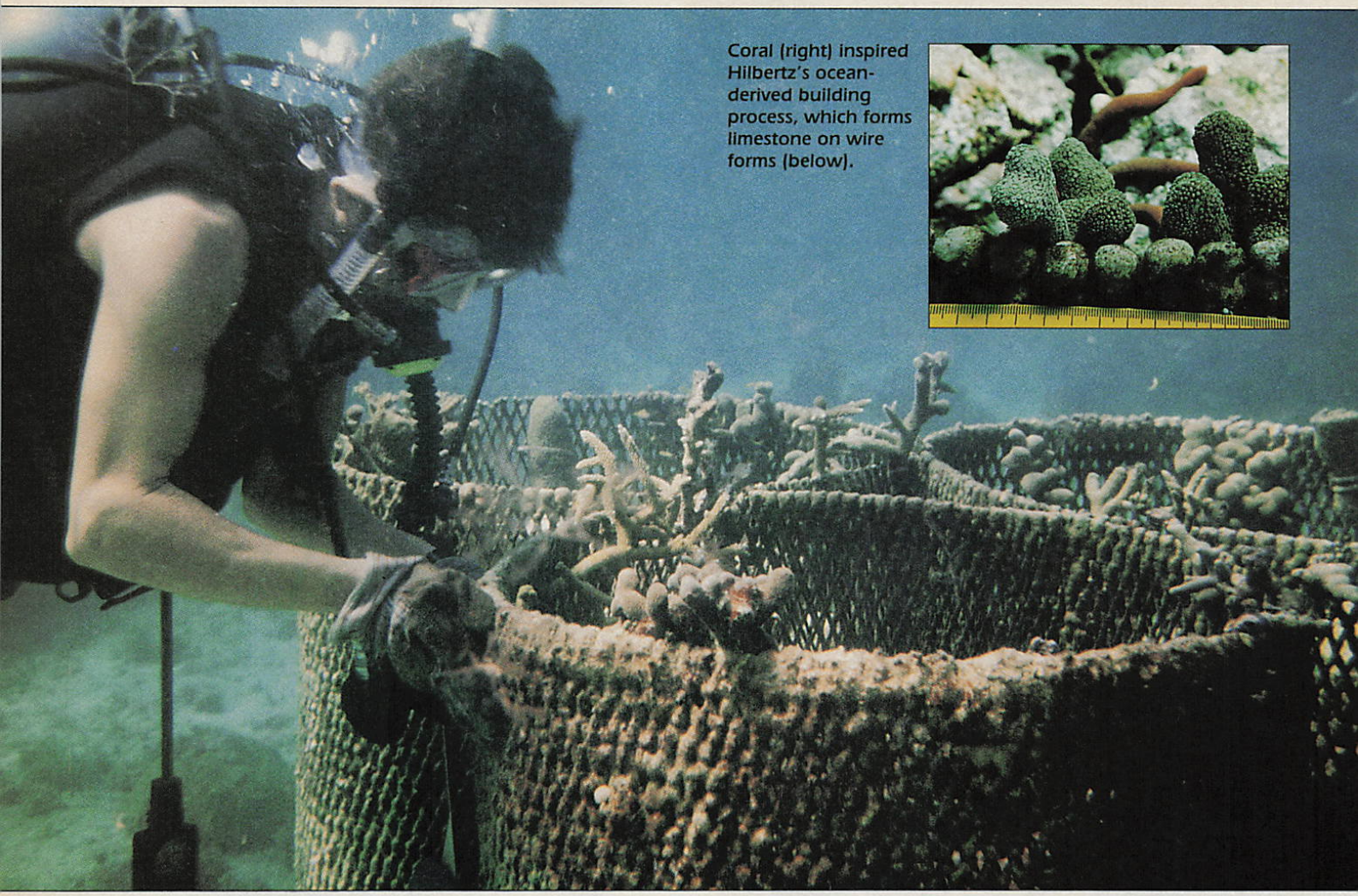
The seas absorb carbon dioxide from the air. Wolf Hilbertz wants to use it to build low-cost housing.

BY ANDY TURNBULL; PM Illustration by David Schleinkofer

● A cargo ship drops anchor in choppy water 300 miles off the coast of North Africa. With practiced efficiency, its crew deploys the ship's crane and begins hauling house-size wire frames and reels of thick electrical cable from the hold. As quickly as this cargo appears topside, it is flung overboard, disappearing into the gray, swirling sea. When the decks are finally clear, the crew begins assembling floating solar panels that look like adult-size tinkertoys. The ship's engines rumble as the first of these ungainly structures is hoisted skyward and carefully deposited alongside. The activity continues until they form a vast spiral that dips below the horizon as the ship

Once completed, Autopia Ampere would become entirely self-sufficient. Wind and sea currents would provide energy. Marine life, both wild and cultivated, would furnish food. The "mineral accretion" process from which the island was built would be used to create building materials for global export. The underwater manufacturing process itself would help to control the buildup of CO_2, which is a greenhouse gas.


David Schleinkofer



Coral (right) inspired Hilbertz's ocean-derived building process, which forms limestone on wire forms (below).

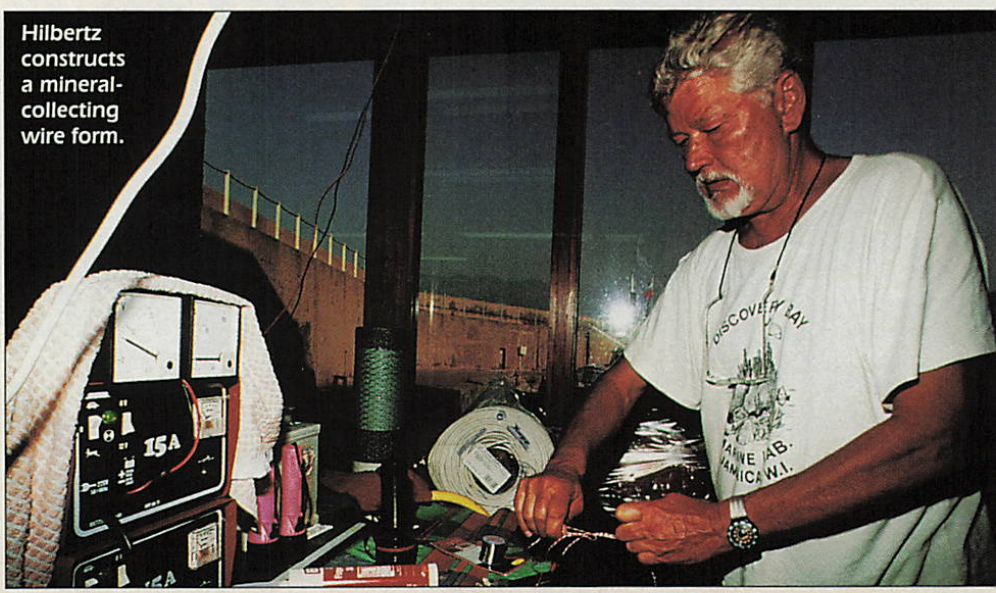
steams away. Five years later, a luxury cruise liner drops anchor at precisely the same place. Instead of finding bobbing rafts, the passengers lining its decks see the thriving island of Autopia Ampere. With a population of 50,000, it is the newest destination for "eco-tourists," an honor befitting its stature as the first city to rise from the sea.

All of this is the dream of German architect Wolf Hilbertz. It represents the ultimate application of the "mineral accretion" building technology he pioneered when he was an associate professor of architecture at the University of Texas. Simply put, Hilbertz has found a way to use sunlight to turn the minerals in seawater into limestone.

Autopia Ampere will begin as a series of wire-mesh armatures anchored atop a sea mountain. Once in place, they will be connected to a supply of low-voltage direct current produced by solar panels. Over time, electrochemical reactions will draw minerals from the sea to the armatures, creating walls of calcium carbonate, which is what us landlubbers commonly call limestone. (See illustration on page 57.) In much the same way that a household sponge absorbs water, the oceans absorb CO_2. By removing carbon-containing compounds from the oceans, the mineral accretion process would help reduce the buildup of CO_2, which is a greenhouse gas.

The idea works in practice as well as theory. Hilbertz began modestly enough, by growing a coating of limestone on wooden piles wrapped in chicken wire at 30 piers on the coasts of Texas, Louisiana and California. He is now a visiting professor of architecture at the Hochschule fur Kunst in Bremen, Germany, and an adjunct professor at McGill University in Montreal, Canada, and he has moved on to a larger project. He invited POPULAR MECHANICS to see a sample of his handiwork that is using the same technology to build artificial reefs off Jamaica.

Working with the Negril Coral Reef Preservation Society, Hilbertz now has five experimental reefs growing around the island. Three of the experiments use power from the shore. A fourth uses a "sacrificial anode," in effect making a wet-cell battery from



Hilbertz constructs a mineral-collecting wire form.

WOLF HILBERTZ PHOTOS

nearby seawater. The fifth runs on solar power.

As a step toward his ultimate ocean-grown city, Hilbertz has planned to grow a self-sustaining island city on Seamount Ampere, which is situated about halfway between the Madeira Islands and the tip of Portugal. If constructed, it will extend 50 ft. down to the bottom of the Atlantic in that spot. Besides shallow water, the site offers good fishing, a dependable ocean current, and polymetallic nodules on the ocean floor that contain copper, cobalt, manganese, nickel and iron.

A huge limestone dam will surround the city, Hilbertz says, and building components will be grown in the sea, as shown in the illustration (right). Solar and wind generators will furnish power. So too will a thermal energy conversion system that will extract power from temperature differences among different ocean currents.

One of the cornerstones of the new city's economy would be "limestone farming." The mineral accretion technique that has built reefs in the Caribbean and that could one day build marine cities could also make building components for use on land. Using appropriately shaped wire forms, the minerals deposited from seawater could grow building blocks, wall panels or complete building components just like those that would build a sea-born city, but for use on dry land.

Hilbertz envisions these products being lifted directly out of the sea into barges and ships, which could deliver them to seaports around the world. A limestone farm in the Caribbean could efficiently ship the building materials to coastal areas of North and South America, Europe and Africa, to inland North American ports on the St. Lawrence Seaway and Mississippi River systems, to most of Central Europe via the Rhine, Rhone and Danube rivers and to most of the Amazon basin in Brazil. A farm in the South Pacific could service the west coast of North and South America, and booming Pacific Rim countries.

Hilbertz also envisions others of his cities becoming centers for an undersea mining industry. The seafloor is believed to be littered with metal- and mineral-rich nodules, from which refiners in a city will produce pure metals. The fact that metals refining is an energy-intensive activity isn't the least bit daunting. He enthusiastically describes a plan in which the sea would "grow" limestone conduits that would tap deep, slow-moving ocean currents and guide them through the blades of giant hydroelectric plants.

Whatever Hilbertz's cities manufactured, their occupants would dine on the bounty of the sea. Wild fish would be guided into nets, and domestic fish would be raised in pens, along with cultured abalone, sea urchins, oysters, mussels and other shellfish. Useful seaweeds will be cultured, and more common vegetables would be grown in hydroponic chambers.

The fact that ocean-grown cities could stand on their own economically and become independent and self-governing entities poses what Hilbertz believes to be one of the biggest barriers to their creation. He says there is no legal precedent regarding national ownership of a newly formed island that is beyond a nation's territorial waters.

He plans to face this issue head-on with an experiment on Skerki Bank, in the Mediterranean Sea. The bank consists of a few-hundred square yards of knee-deep water between Tunisia and Sicily. It's in international waters, but within the area both Italy and Tunisia claim as an "Exclusive Economic Zone."

Hilbertz hopes to start growing an island there before the end of the year. "We'll establish our presence there and stake a claim, and see what happens. If anyone challenges us, we have lawyers ready to argue our case. We've had so many legal opinions that we decided just to go ahead and see what happens," he says. **PM**

PM ILLUSTRATION BY PAUL DIMARE

COVER STORY

EXTREME TRUCKS

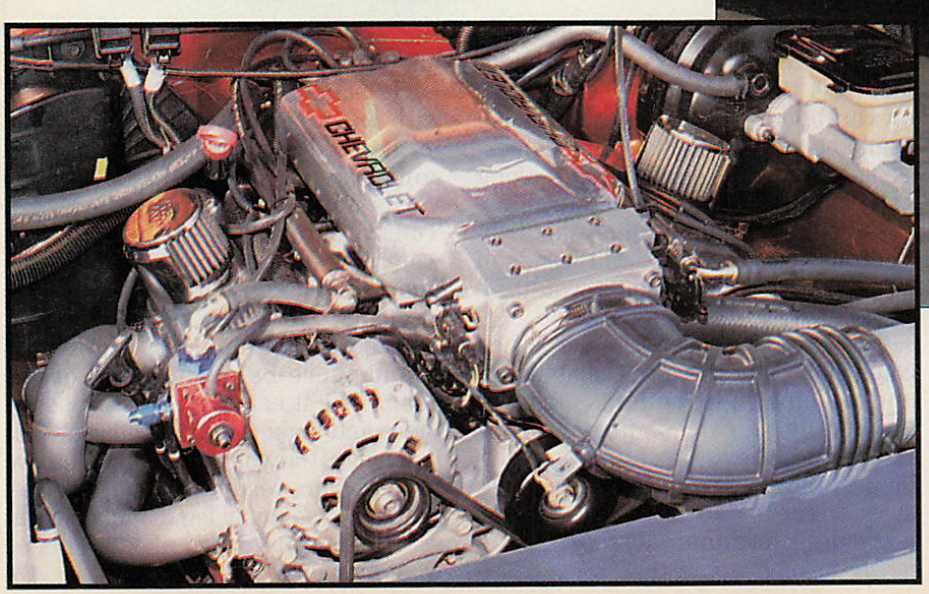
Detroit's truckmakers punch the walls out of the small-truck concept.

BY CLIFF GROMER, Contributing Editor
PM Photos by Cliff Gromer and Bill Erdman

● Extreme is in. Mundane is out. Take professional wrestling, for example. Simply body slamming your opponent to the canvas, as they do in the World Wrestling Federation, is mundane. It's out. Coming off the top rung of a steel cage and smashing your opponent through three tables to the mat, as they do in Extreme Championship Wrestling, is extreme. And it's in.

The same goes for trucks. Since pickups and sport/utilities are today's hottest sellers, it makes sense that the Detroit makers would give their designers and engineers the chance to let their imaginations run wild and push truck concepts—and design technology—to the extreme.

So Chrysler, Ford and Chevrolet have come up with trucks that go way beyond pushing the envelope. These haulers grab the envelope, rip it apart and stomp on the pieces. These pickups and sport/utility vehicles are not just tape-and-decal jobs, but seriously designed trucks that pack extreme muscle to complement their extreme character.



CHEVROLET X-TREME FORCE

Let's face it. If a truck doesn't do it for you when you punch the gas, everything else is a waste. Take it from us, X-treme Force will do it for you. This Orange Glow S-10 Fleetside with grafted-on Sportside rear fenders can run and handle with today's hottest production cars.

The heartbeat of this pickup is a GM

Motorsports 450-horsepower 4.5-liter V6 that's stuffed with aftermarket speed parts and hooked to a 4-speed automatic and 4.10:1 rear. This combination is potent enough to haul this hauler down the quarter mile in a scorching 13½ seconds. To put this into perspective, that's quicker than the '97 Mustang Cobra SVT that we tested last month (see "Showdown!" page 58).

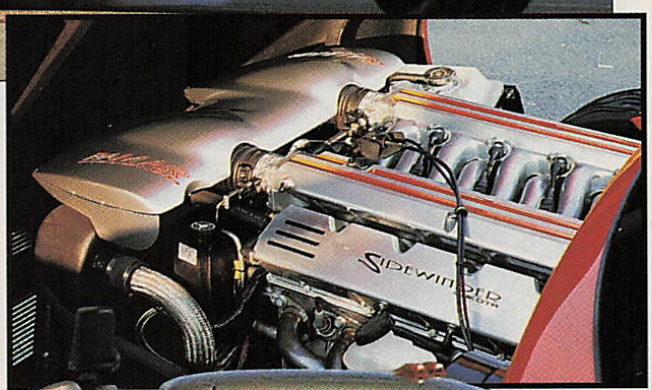
For those into nipping apexes and drifting around on-ramps, GM's ZQ8 suspension meets the challenge. Ride height is cut 2 in., while gigonda BF-Goodrich tires (275/40ZR17 front, 335/35ZR17 rear) on Boyd wheels provide the all-important contact patches. No point in putting this baby on the roof. That's *beyond* extreme.

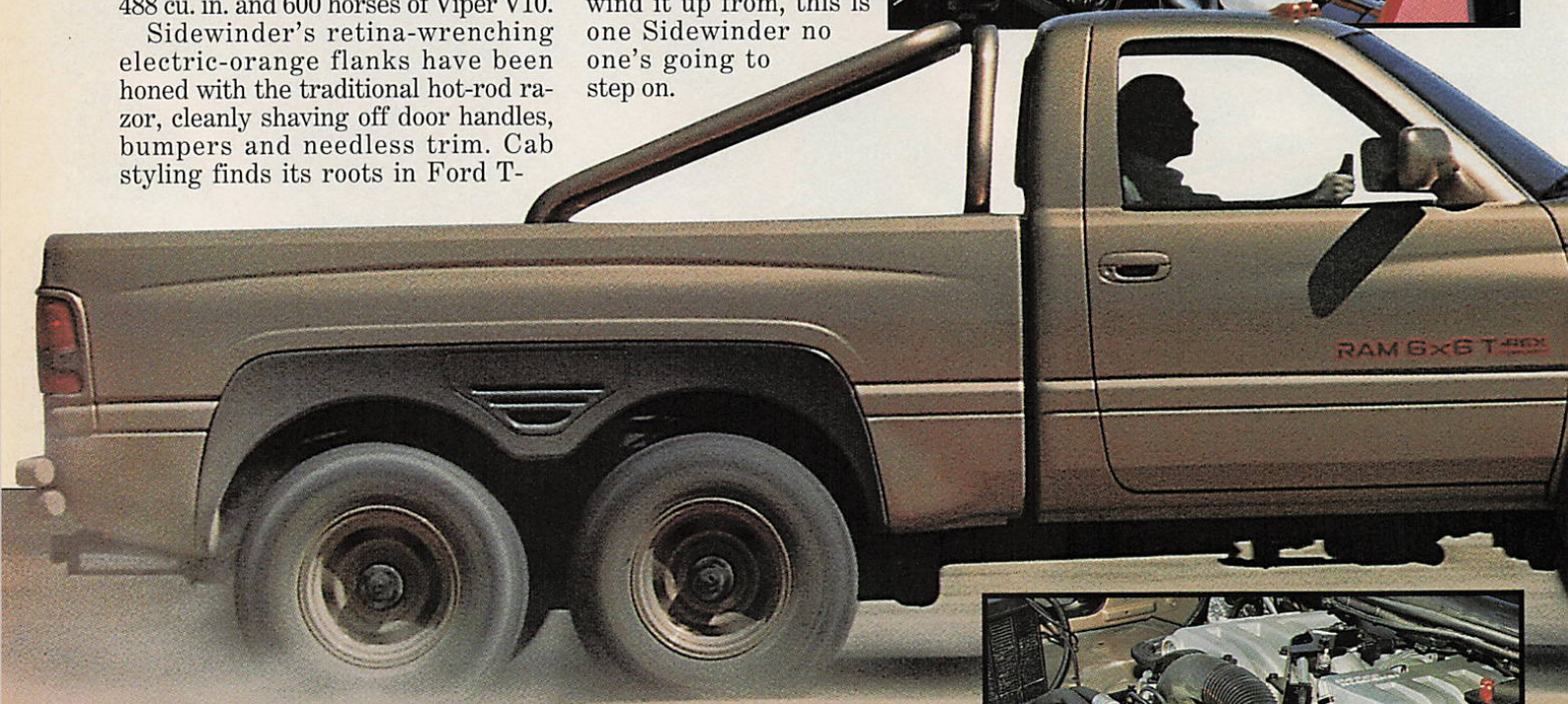
The beauty of this package is that the extreme hormones needed to transform any stock S-10 2-wheel-drive pickup into the nasty X-treme Force version you see here are available at any Chevrolet dealer parts counter. So even you can move from the fast lane into the extreme lane.

DODGE DAKOTA SIDEWINDER

Monster engine, humongous wheels and tires, outrageous appearance. That's the formula for the classic American hot rod. And that describes the Dodge Dakota Sidewinder—the nastiest sport pickup ever to roll out of Motown. Starting with a '97 Dakota front end, Chrysler stuffed Sidewinder with the biggest mill it could find—488 cu. in. and 600 horses of Viper V10.

Sidewinder's retina-wrenching electric-orange flanks have been honed with the traditional hot-rod razor, cleanly shaving off door handles, bumpers and needless trim. Cab styling finds its roots in Ford T-bucket rods, while a modern and sophisticated suspension with front double wishbones and a 5-link rear keeps the 21-in. front and 22-in. rear tires in intimate contact with Mother Earth. We don't care which side you wind it up from, this is one Sidewinder no one's going to step on.

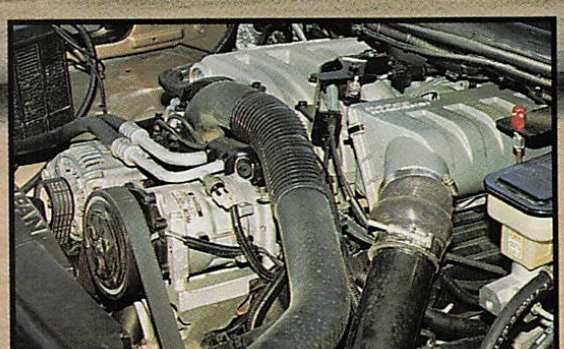




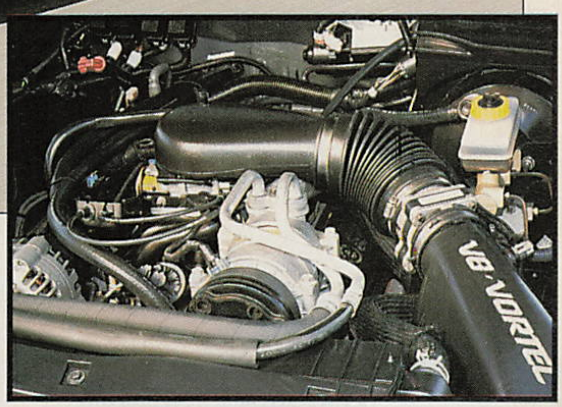
DODGE T-REX

You think your 4x4 pickup is tough? Forget it. It's a wimp. Meet T-Rex, the baddest, meanest off-road truck ever to brutalize the environment. Forget 4x4. T-Rex is a 6x6. Any more wheels and this sucker would be a freight train. How does a 500-horsepower V10 grab you? How about a tow rating of 26,000 pounds? Forget about trying to load all that stuff your wife wants to bring on the family picnic. T-Rex will tow your entire house.

To get around the weight and packaging problems associated with using military or commercial axles—the usual route for a 6x6 drivetrain—those sneaky Chrysler engineers used a unique externally mounted transfer case mated to a pair of off-the-shelf heavy-duty light-truck axles. A transfer-output shaft powers the second axle and a chain-driven over-the-shoulder prop-



CHEVROLET XTREME+4

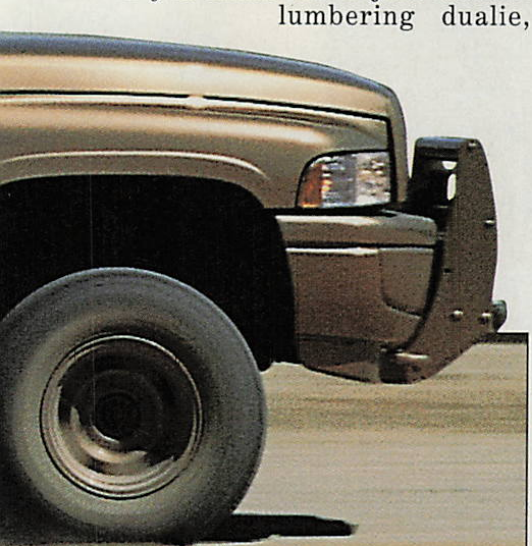


Cram a 250-horse 5.7-liter Vortec V8 into a compact Chevrolet S-10 pickup, and you have a truck that thinks it's an Impala SS. And that's just for starters.

When did you ever see a dualie S-10? You haven't—until now. Ditto for a full 4-door crew cab, unless you live in Brazil where Chevy sells that model.

Like kids in a candy store, Chevy engineers grabbed parts from various goody bins to cobble up Xtreme+4. The stock frame got a 17-in. implant so it would accept the standard S-10 box. Flares cover the heavy-duty dualie axle that's pirated from the full-size C/K pickup.

If you think this is just another lumbering dualie, just punch the hot pedal. It'll open your eyes wider than your morning's double espresso. For a sub-8-second 0 to 60 and a high-15-second quarter-mile time, a lowered ride height and F-car modified rear disc brakes improve the handling. Wrap up the whole deal with a special grille and 16-in. billet aluminum wheels, and you have the ultimate dualie.

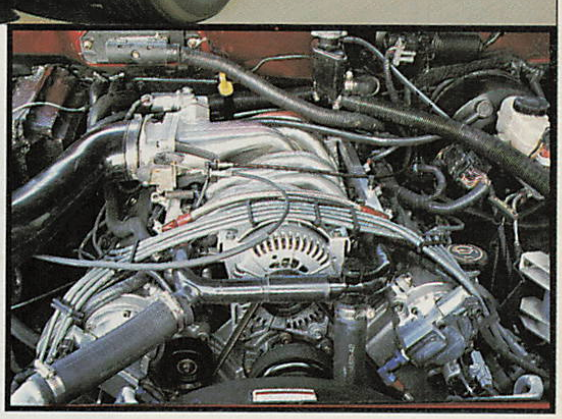


shaft delivers power to the third.

An air suspension system with driver-selectable ride control and height adjustment is another goody.

As a viable alternative to a dualie setup, the 12,000-pound (GVW) T-Rex 6-by is production-possible. Chrysler says it burns up the quarter mile in 16.1 seconds, goes from 0 to 60 mph in 7.7 seconds, packs a 0.74-g cornering force and can pull your house down.

FORD TREMOR

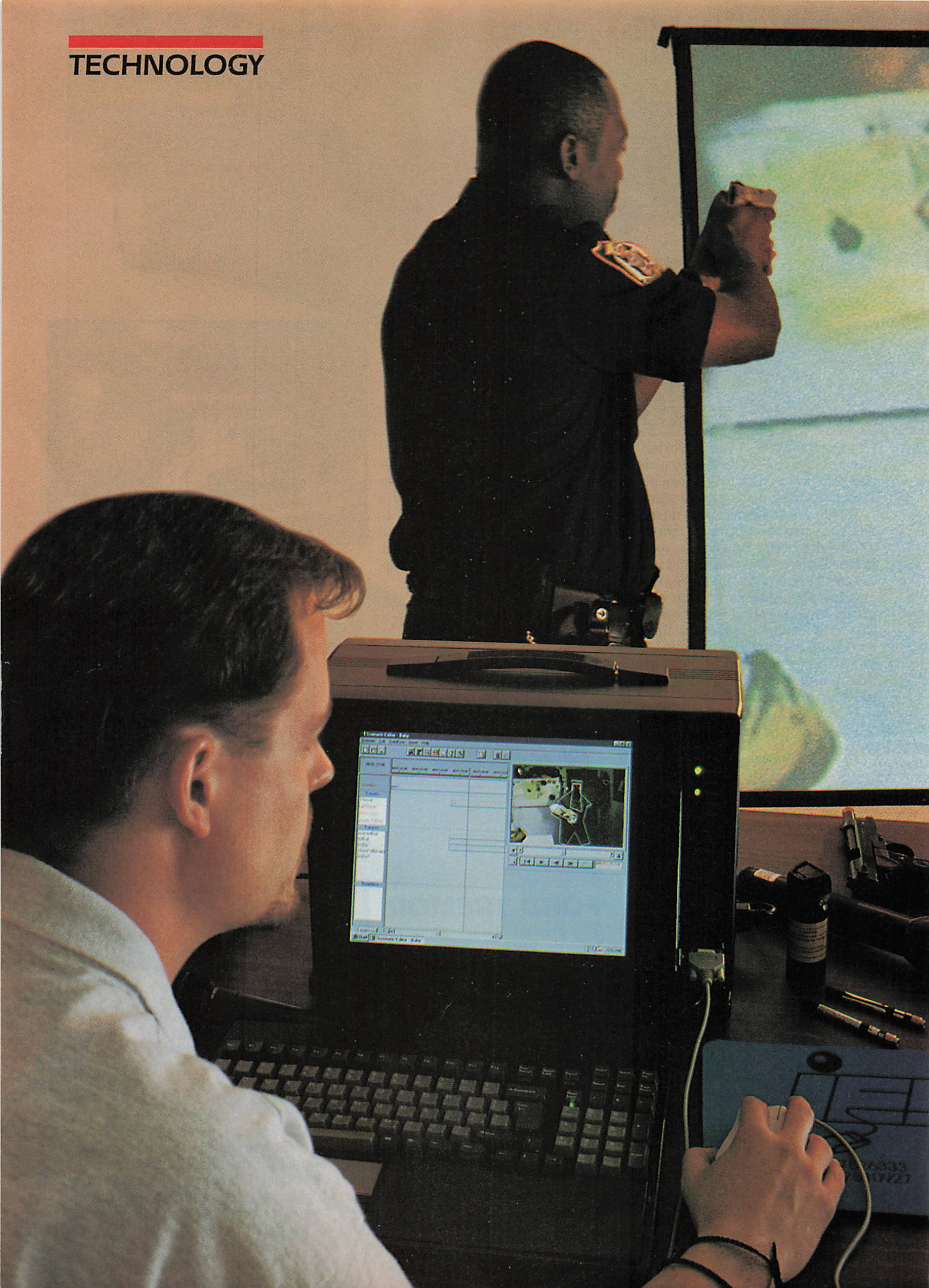


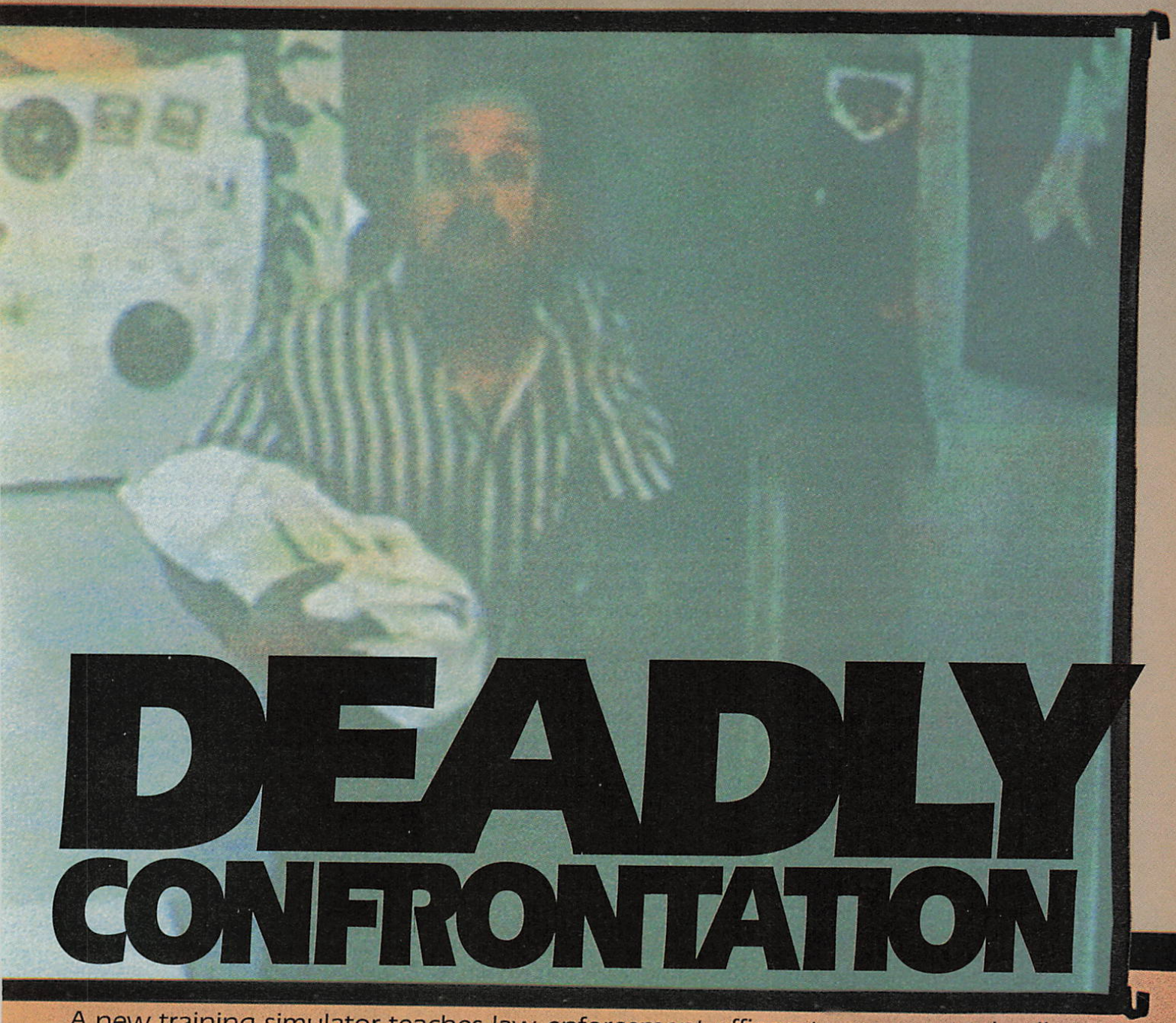
The ground shakes when you twist the key in Tremor. In addition to an open exhaust, 380 horses are lolling around in this Explorer-based sport/utility's all-aluminum 4.6-liter 40-valve dohc V8. That's right, five valves per cylinder.

But even with the engine at rest, the styling touches on this truck scream for attention.

Production Explorers are saddled with a solid rear axle. But the awd Tremor coddles its occupants with an independent rear suspension. Two-way adjustable gas shocks, a rear stabilizer bar and a 2-in.-lower ride height all contribute to solid handling.

Putting the 4900-pound 4-wheeler to the test yields quarter-mile excursions in less than 15 seconds with 0 to 60 mph in the high-6-second bracket. And should the need arise to beat the big bad wolf to grandma's house, a top speed of nearly 140 mph is just a push of the pedal away. **PM**





DEADLY CONFRONTATION

A new training simulator teaches law-enforcement officers to save, not take, lives.

BY FRED MACKERODT, Contributing Editor; PM Photos by Skip Gandy

● The Glock 17 hangs at my side. The gun feels cool in my sweaty hand. I finger the trigger as a terrified woman's voice pierces the air.

"Help! He's going to kill me and the baby!"

The adrenaline begins to flow, numbing the tips of my fingers and toes. I can feel my pulse rate climb.

Turning the corner from the living room into the kitchen, I see the man. His left arm is around the screaming woman's throat. She clutches an infant close to her. Glaring at me, the man begins to raise his free hand—and I see the gun.

As fast as I can, I lift the Glock and get off five quick shots. The deafening din of gunfire fills the room.

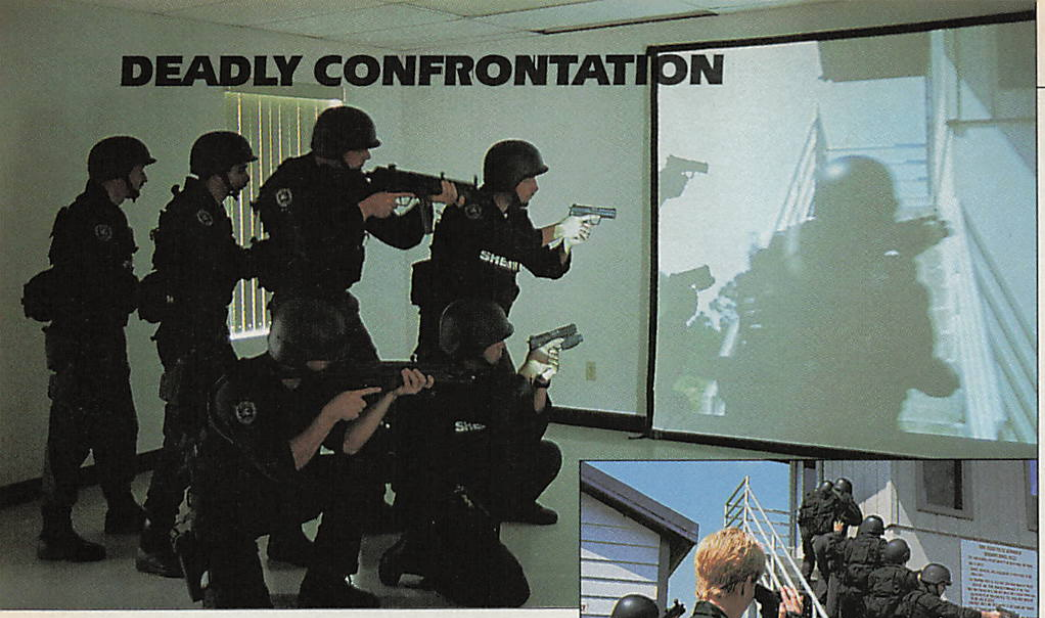
The outcome? Thank God it was a simulation! I was "killed" by the gunman, but even that wasn't the worst part. The technician tracking the output of the laser insert mounted in the Glock's barrel gave me the bad news. I didn't come anywhere near the hit zones outlined on the screen. My second shot hit the floor in front of the culprit, the third went into the ceiling, the fourth struck a pot on the stove, and the last shot blew the infant out of the woman's arms.

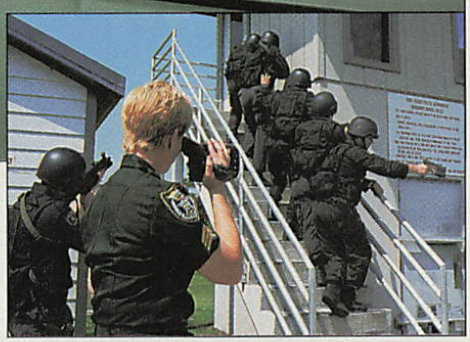
What happened to my first shot? As far as we could tell, I probably shot myself in the foot while bringing the gun up to firing position.

My performance was abysmal, but understandable. After all, I'm not a professional law-enforcement officer and I have limited experience with firearms. And it was a first-time happening for me. I wasn't ready for it. But neither are most police officers. Few police officers have encountered situations that require the use of deadly force. And most of the officers who have survived shooting incidents did so out of pure luck.

The simple truth is that most police officers don't train for potentially deadly confrontations. At most, they're taught a little theory and go to the range once or twice a year to take potshots at stationary targets. But there's much more to successfully handling a con-

DEADLY CONFRONTATION





Range 2000 allows trainers to customize scenarios using a common camcorder.

frontation than aiming a gun and hitting a target. Studies have shown that officers involved in shooting incidents usually can't recall any details from the 5 seconds before and 5 seconds after they pull the trigger. Stress clouds perception. Because of this, any action an officer takes during those seconds has to be a learned response—the reaction must be automatic.

The incredibly realistic simulation I experienced in the training department of the Indian River County (Florida) Sheriff's Office was produced by a high-tech system developed by IES, an Israeli company. Called the Range 2000, the system was developed for the Israeli and U.S. military to combat international terrorism and is now available to law-enforcement agencies in this country.

It consists of a sophisticated digital video-projection system controlled by an IBM-compatible computer with a 133-megahertz Pentium chip. An important and unique feature of the system is its ability to "branch." This means the sequence of events that unfolds on the screen in front of the officer is determined by his or her reaction to individual segments as they come up on the screen. Says Greg Otty of IES, "The major thrust of our training is to defuse a situation. If the officer being trained utilizes the correct verbalization and body language, the confrontation on the screen in front of the officer can play out peacefully." The training also stresses the use of appropriate force, whether that be a firearm, a baton or even pepper spray. The officer has to choose which level of force to use, and, through the use of laser-equipped accessories, the subjects on the screen will react appropriately. The Range 2000 can also be used for night training, thanks to a laser flashlight which lights up the area of the screen where it is pointed.

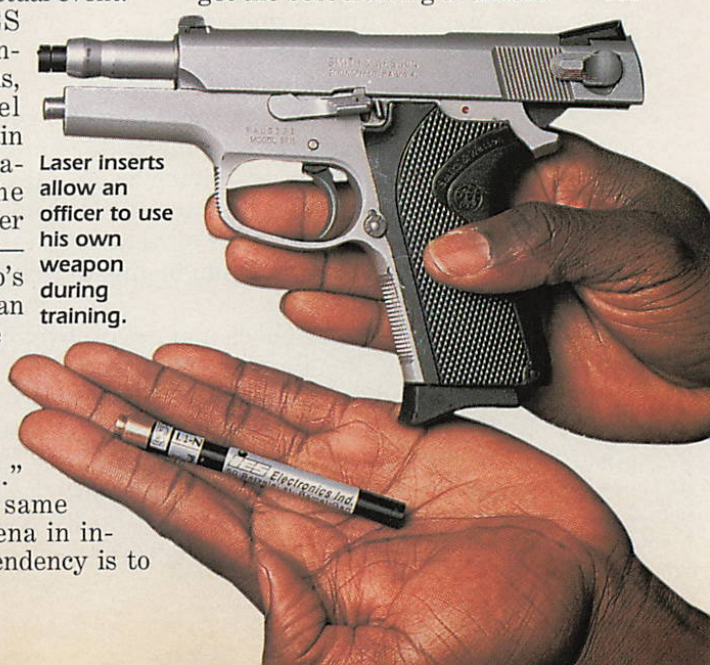
A very unique feature of Range 2000 is that any law-enforcement agency using the system can create its own scenarios. Says Sgt. Melissa Hill, training officer of the Indian River County Sheriff's Office, "For us, that's one of the main attractions of this system. We can videotape training scenarios in environments our deputies are familiar with, such as the local bank and the jail. We can also use our own procedures and people speaking in the local vernacular with local accents. You can't do that with a canned training scenario." To produce the scenarios, Hill uses actors from a local theater group. Why not real cops? Even though police officers use role-playing every day on the job, "cops make rotten actors," Hill says. Hill is also producing scenarios for the office's SWAT team to use. "We can surreptitiously tape a location before we go in. Then, using the Range 2000's editing feature, we can train officers right on the 'virtual' site of the future strike. That way, our team members can practice over and over and focus on the big picture before the actual event."

Rich Daniel, the IES technician who demonstrated the system for us, points out that tunnel vision is one of the main problems in confrontational situations. "The tendency is for the officer to fixate on the target—be it a gun in the perp's hand or a door where an entry is going to be made. But a threat can come from any direction, and the idea is to create scenarios that illustrate that point." Pilots experience the same tunnel vision phenomena in instrument flight. The tendency is to fixate on one instrument. To counter this, flight training instructs the pilot to scan all instruments.

The Range 2000 system stores scenarios on high-speed Iomega Jaz disks that are inserted into the controlling computer. Each disk stores 1 gigabyte of material, allowing up to 1 hour of video. The operator can then edit the output, determining ideal strike zones and otherwise customizing the training. The system also records the performance of the officer being trained, gauging his or her development.

An interesting option allows the use of live ammunition. In this case, the screen used has two layers. After a session is graded, using an infrared lamp behind the screen which shines through the bullet holes, the second layer of the screen moves a fraction of an inch to cover the holes and the screen is ready to be used again. The standard system includes a laser insert which fits into the barrel of the officer's service weapon. This laser comes with sleeves to fit the various-caliber weapons used by law-enforcement agencies, and is powered by a hearing-aid battery good for 2500 shots. Audio is supplied by 32-bit Sound Blasters.

But if systems like Range 2000 and the associated training are available to law-enforcement agencies, why aren't they utilized everywhere? It comes down to one thing—money. A system like the Range 2000 starts at $35,000. "Not providing police officers with the best training tools available is really false economy," says Indian River County Sheriff Gary Wheeler. "Our greatest asset is our deputies, and they are only as good as the training they get. Besides, one lawsuit can easily cost 10 times as much as proper training. I have deputies on the road 24 hours a day, all alone, facing God only knows what kinds of situations. I sleep much better knowing that they get the best training available." **PM**



Laser inserts allow an officer to use his own weapon during training.

TOP GUN FROM CANON

EOS IX is the latest salvo fired into the advanced photo system market.

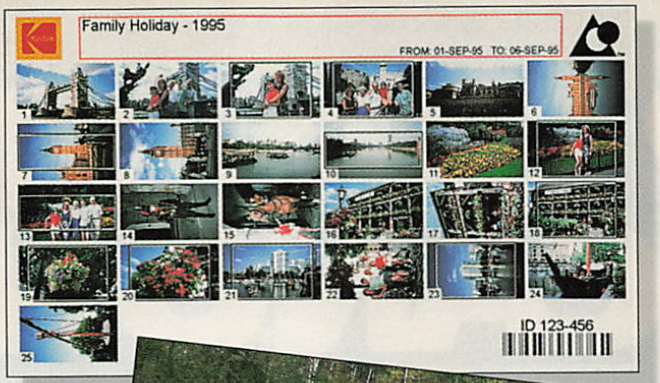
BY CLIFF GROMER, Contributing Editor

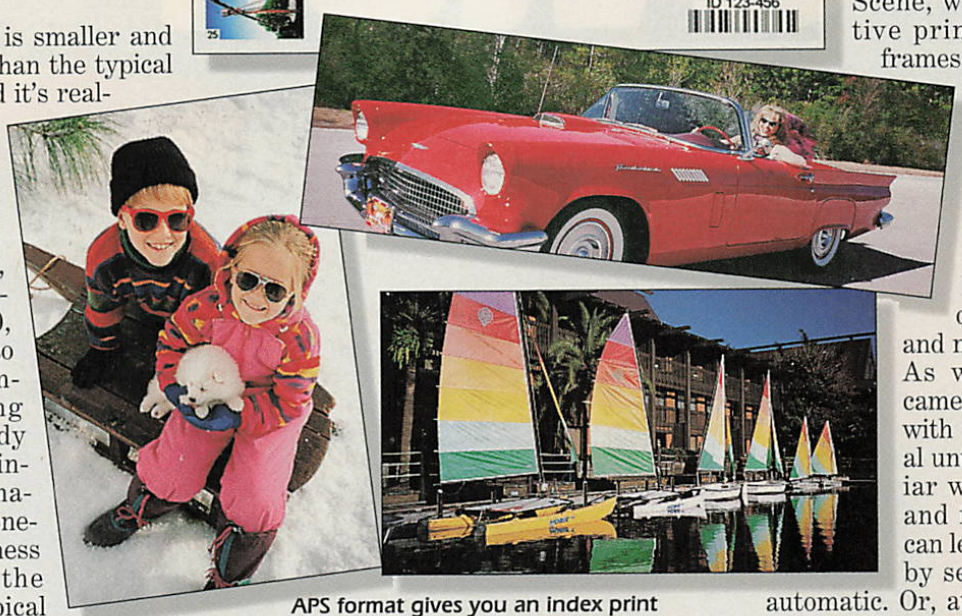
● If there was any doubt that the new advanced photo system, or APS, (see "Film Star," page 68, May '96) would filter up from the point-and-shoot masses into the ranks of serious photographers, Canon's new EOS IX camera is the convincer. A high-end piece of hardware for the amateur photographer, the EOS IX packs the performance features of Canon's highly regarded EOS 35mm SLRs. What makes EOS IX really click is that it accepts the full line of more than 50 SLR autofocus (AF) EF-mount lenses, which

PM PHOTO BY A. GREG ALTER, ASSISTED BY J. LAMONTE; VIESTI ASSOCIATES INC./JOE VIESTI PHOTO (INSET)

range from a superwide 14mm and fisheye 15mm to a serious 1200mm super telephoto. Included in the mix are Canon's unique image stabilizing lenses, tele extenders and special tilt-shift lenses. Combine this with the unique benefits inherent in APS, and it's obvious we're not playing in the drugstore blister card camera league.

The EOS IX is smaller and more compact than the typical 35mm SLR, and it's really comfortable in your hand. The smaller 24mm film size that the APS format uses, known generically as IX 240, helped Canon to shrink the camera. Wrapping the camera body in SUS316 stainless steel—a material that has one-third the thickness and 10 times the strength of typical molded casings—also cut bulk as well as weight. The mirror-prism viewfinder is smaller and lighter than conventional refractive-prism viewfinders, but the tradeoff sacrifices viewfinder brightness.





APS format gives you an index print showing all your shots, and choice of three print sizes: 4 × 6 classic, 4 × 7 wide angle and 4 × 10 panoramic.

When using standard 35mm Canon lenses, the smaller image area of APS film gives you slightly larger images—compared to 35mm film—at any given focal length and print size. A wide-angle 24mm lens, for example, produces the image equivalent of a 30mm lens in 35mm format. A 50mm normal lens produces an image equivalent to a 63mm, while the APS image produced by a 600mm telephoto is the approximate image size of a photo shot with a 750mm lens in 35mm format.

Virtually all APS cameras, including the EOS IX, offer basic features such as leaderless drop-in film loading, and they also give you three choices of print sizes or aspect ratios. Recorded information on exposure, lighting particulars and flash information tells the processing machines under what conditions each shot was taken so they can compensate to make the best possible print in terms of color balance and density—the closest thing yet to automated custom printing. The EOS IX can also have the processing equipment automatically imprint the date, time and exposure data for each shot. The camera's ability to read as well as write to the film allows midroll change capability. This lets you remove a partially exposed roll and reload it later, and the camera automatically advances the film to the first unexposed frame.

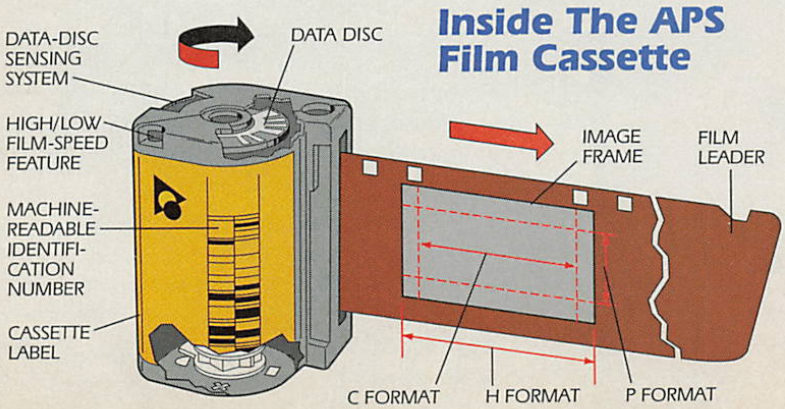
While lower-end APS cameras make use of some of the system's features, the EOS IX pulls all the tricks out of the APS bag. Selectable Fixed Time Printing Method, or FTPM, tells the processing machines not to compensate for intentional incorrect exposures, such as bracketing. Similar to FTPM is Series Scene, which blocks corrective printing to individual frames instead of the entire roll. Series Scene kicks in whenever the camera's auto bracketing or auto exposure lock features are used.

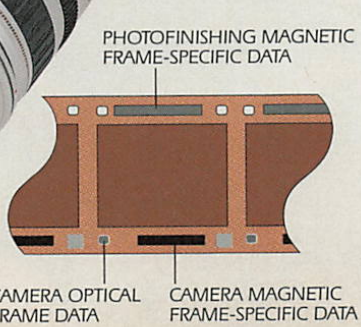
The rest of the EOS IX story is one of sophisticated focus and metering capabilities. As with any high-end camera, expect to curl up with the operating manual until you become familiar with all the controls and features. Sure, you can let the camera do it all by setting everything on automatic. Or, at the other extreme, you can manually set the shutter speed, lens aperture and focus, if you're so inclined.

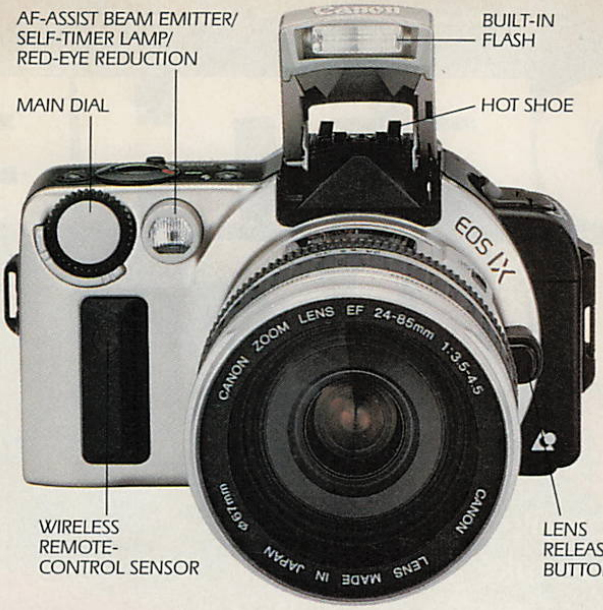
Autofocus uses a 3-point system. In addition to regular AF, you can select a focus point to the right, center or left area of the image. When shooting an off-center subject, for example, the system virtually eliminates the need to focus. Three AF modes increase your chances of getting sharp shots. The One Shot AF mode selects the closest subject from all three focusing points. AI Servo mode tracks a

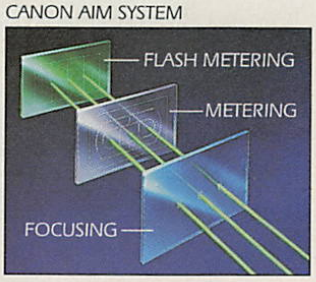
EOS IX comes either as just a body or with a matching-finish EF 24-85mm f/3.5-4.5 zoom and a sub-$1000 street price.

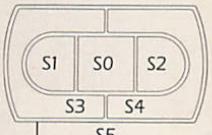
Inside The APS Film Cassette

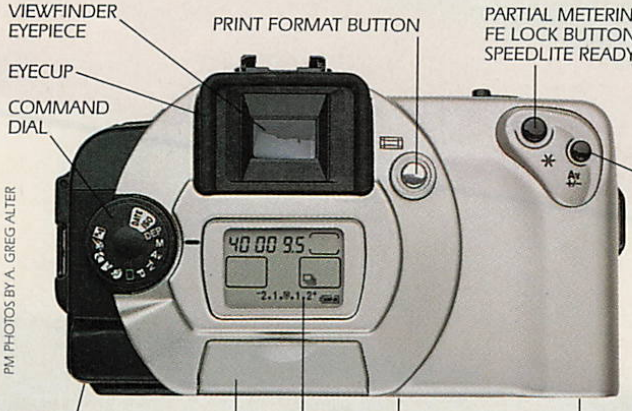




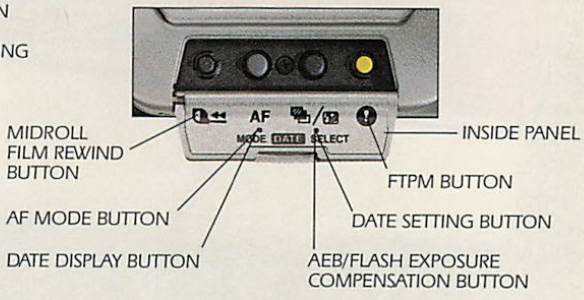








PM PHOTOS BY A. GREG ALTER



moving subject, and AI Focus automatically switches from One Shot mode to AI Servo mode whenever the subject moves.

An intelligent metering system that Canon calls Advanced Integrated Multi-point control (AIM) integrates information from the autofocus, auto exposure and flash exposure systems to give you the best picture no matter where the main subject is positioned, and whether or not flash is used. The three focusing points in the AF system each have corresponding zones in the metering systems used for available light and flash calculations. You get more correct exposures in scenes with very bright or dark backgrounds—situations that usually fool most metering systems.

Auto exposure uses a 6-zone metering mode that links the three main zones of the sensor to the three corresponding points of the AF system. Metering is weighted according to the active focusing point. Center-weighted metering and spot metering are other options.

The camera's command dial lets you choose from a number of exposure programs. Each program selects a specific metering pattern, film advance mode, AF mode, flash mode, shutter speed and lens aperture. In addition to Full Auto, you can dial in programs for portraits, landscapes, closeup shots, sports and night shots. For greater creative control, you'll find the usual shutter priority, aperture priority, depth-of-field and manual exposure control options, in addition to a general-purpose exposure program that automatically compensates for lens focal length.

For flash photos, the EOS IX comes with a built-in pop-up flash that uses TTL metering linked via the AIM system to the three AF focusing points. But you'll need Canon's optional 380EX or 220 EX Speedlites to take full advantage of the camera's flash technology. Where conventional TTL and A-TTL flash systems control exposure based on light reflected and measured off the film surface, the Speedlites use Canon's E-TTL system. Here, a preflash reflected off the subject helps the 6-zone evaluative metering system analyze the ambient/flash lighting of the scene for more natural illumination.

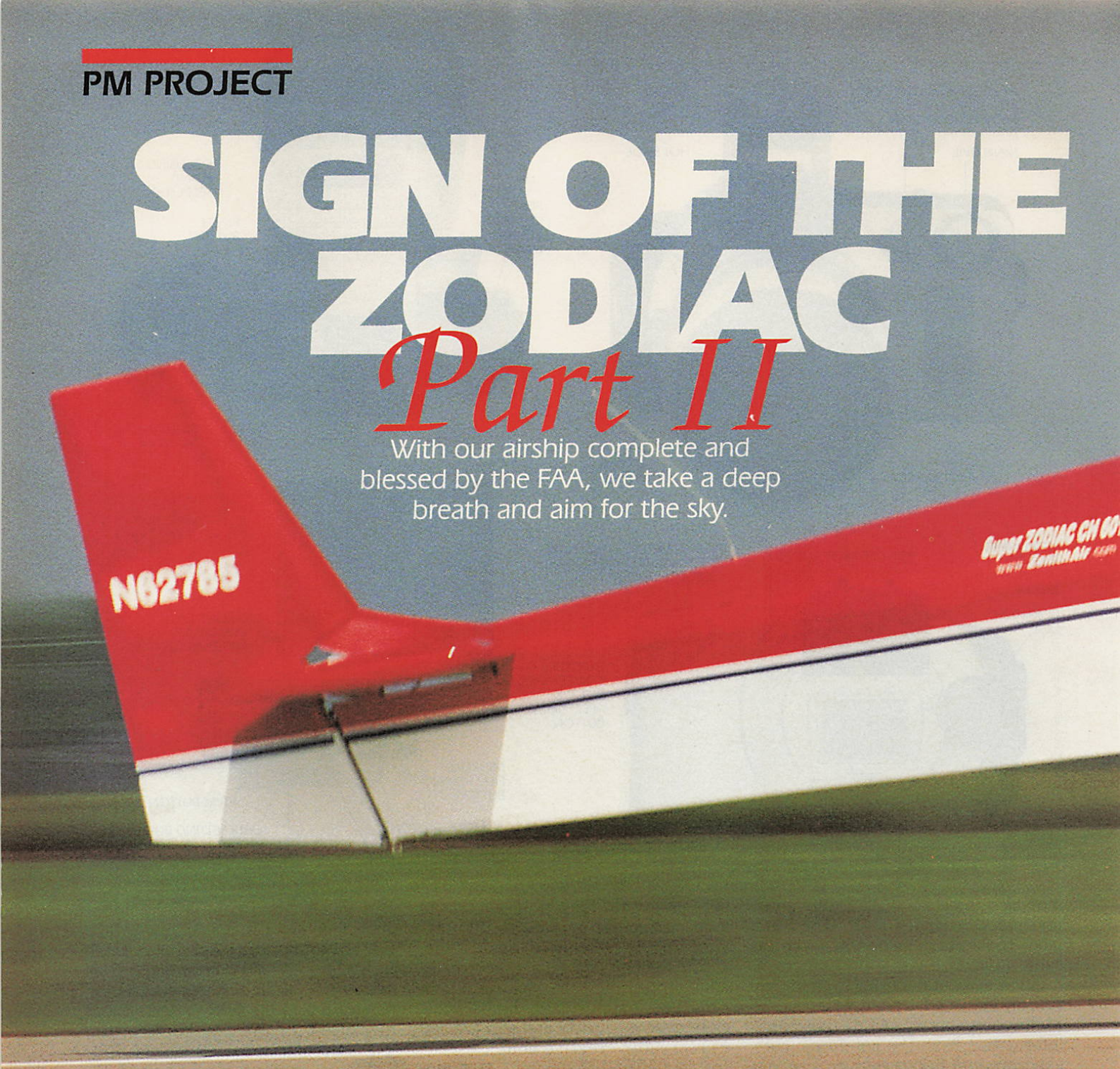
With all the sophisticated and convenient features of the EOS IX, plus the increased sharpness of the new APS films, Canon has given silver-based film an edge against the oncoming wave of digital photography. **PM**

PM PROJECT

SIGN OF THE ZODIAC

Part II

With our airship complete and blessed by the FAA, we take a deep breath and aim for the sky.



BY CLIFF GROMER, Contributing Editor
PM Photos by Cliff Gromer, James A. Sugar, Roger Dubbert and Dale McCoy

● Unlike many airplane kit projects that end up partially completed and dumped in the classifieds, our Zodiac escaped the common kit pitfalls of poor design, loss of builder interest and marital hassles. The Zodiac kit is well designed, our interest was maintained at a fever pitch by repeated phone calls from the editor reminding us about impending deadlines, and our wife was 1000 miles away.

In our last episode ("Sign Of The Zodiac," page 46, Aug. '97), we were 350 hours into the project, and well ahead on the learning curve of metal aircraft fabrication. The Zodiac airframe was complete and awaited paint, instruments, canopy and engine.

The instrument panel had been sent to Gulf Coast Avionics for installation of flight and engine instruments, navigation and communications equipment and panel prewiring. Gulf Coast is one of the larger avionics facilities in the United States, and while they do a big business in kitplane panels, they also sell and service a full range of avionics products for everything from ultralights to the big bizjets.

For nav/com equipment, we went with a Bendix-King KLX 135A GPS/Com unit. It features a moving map display and packs a fantastic amount of capability into a very compact package. Judging from its performance, size and price, it's the best unit of its

kind on the market. The companion Bendix-King KT 76A Mode A/Mode C transponder is our ticket to controlled airspace and also delivers outstanding performance at a relatively modest price.

Of course, we just had to have one of the slick new handheld GPS units for backup and to give bored passengers something to fiddle with. Our choice here was the Magellan SkyStar GPS. The most affordable of these feature-packed GPS units, the SkyStar does everything except serve you orange juice.

Back at our workstation in the corner of the Zenith factory, our plane was trailered back in sections from the paint shop, and we set about bolting on the wings and tail assembly and connecting the control cables. The acrylic bubble canopy is a clever design offering panoramic visibility. We drilled and riveted through the plastic to attach the bubble to the aluminum tube frame. The tube frame runs fore-aft along the lower sides of the canopy and engages dual latches on either side of the cockpit. The clamshell design allows each side of the canopy to open almost vertically for easy entry and exit for pilot and passenger. We drilled the instrument panel, now chock-full of gauges, for the dual throttle rods and choke cable, which left only the engine and prop to be installed.

The Zodiac is designed to take 65 to 115 horsepower. Our engine of choice, and the most popular kitplane engine in this class, was the Rotax 912. The 912 pumps out 80 horsepower and is a horizontally opposed 4-cylinder 4-stroke with dual electronic ignition, electric starter, liquid-cooled heads and air-cooled cylinders. An integral 2.27:1 reduction system slows the prop from the engine's 5000-5500-rpm cruise to 2200-2425 rpm. The 912 is designed as an aircraft engine from

We found the Zodiac to be comfortable, responsive and easy to fly.

the ground up, as opposed to being a converted auto or snowmobile powerplant. Zenith offers a firewall forward kit for the 912, which takes the hassle out of hanging the engine.

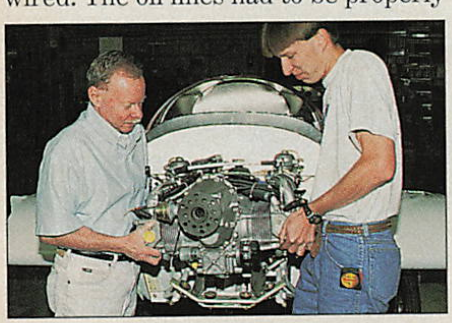
Well, at least most of the hassle. First we had to plan the location of the dry sump oil tank, then we had to fabricate a bracket to mount it to the firewall. Same for the battery. The engine bolted right into the supplied mount, and the bolts had to be safety-wired. The oil lines had to be properly routed, as did the radiator coolant lines, which we mounted horizontally underneath the fuselage. There is no fan or water pump because the cooling is dependent on thermal siphoning. We then had to safety-wire every single hose clamp.

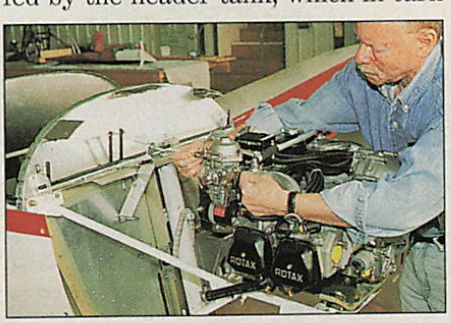
Electrical wiring is a matter of following the construction manual, and fuel-line routing is common sense: Avoid sharp bends and keep the lines away from heat sources. The engine is fed by the header tank, which in turn pulls fuel from both wing tanks via a manually operated electric fuel pump mounted under the seat.

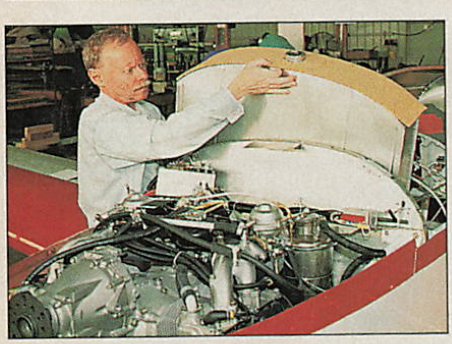
The beauty of a homebuilt is that you can use good-grade automotive and other suitable application components that do the job at about one-tenth the cost of comparable aircraft components. Our throttle cables, for example, are bicycle brake cables that we bought at Wal-Mart.

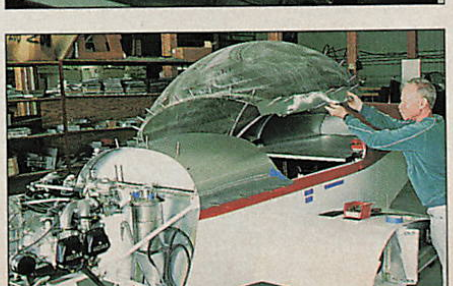
The last requirement was to determine weight and balance—the center of gravity (CG) envelope of the plane. This involves actually weighing the aircraft using three scales—one under each wheel—and calculating the envelope, which determines the maximum weight we can add at locations fore or aft of the CG line—in this case, the leading edge of the wing. A plane that is loaded outside of the envelope will be unstable—and probably uncontrollable—in the air. Our plane weighed in at 603 pounds with a max gross weight of 1200 pounds.

Taxi tests showed that the engine worked, the plane tracked true and the brakes functioned. But the real value of low- and high-speed taxi tests comes from uncovering potential problems and correcting them before the plane gets into the air. We couldn't legally take our wheels into the air until the plane was inspected and blessed by the FAA. Designated Airworthiness Representative Earl Neff, a private inspector contracted by the FAA, went over the stack of required forms, looked over our in-progress construction photos and scanned our builder's logbook as evidence of our actually constructing the plane. Then Neff pored over the aircraft itself, using a flashlight and mirror to inspect hard-to-access areas like the control cable attachment points at the rudder and ailerons. He even used a gauge to make sure









Above (top to bottom): 128-pound Rotax is easily mounted by two people. Header fuel tank fits between firewall and instrument panel. Center: Bicycle brake cables actuate throttles. Horizontal stabilizer is installed after painting. Completed instrument panel shows flight gauges on left, engine gauges on right. Bendix-King GPS/Com and transponder are stacked in lower center of panel. Right: Control cable attaches to rudder pedals. Canopy gets a test fit.

the control cable tension was in spec—in our case, 30 to 40 pounds. Neff suggested rerouting a fuel line and resecuring some wiring, and he requested a neater safety-wiring job on an aileron control cable turnbuckle. After complying with all of the above, we were rewarded with our Airworthiness Certificate and the approval for our Aircraft Repairman's Certificate, which allows us to work on our plane. It was like dad giving us the keys to the car for the first time.

We wasted no time in taking advantage of the opportunity. We fired up the Rotax and taxied out to Runway 18 of Mexico Memorial Airport, Mexico, Missouri. We checked the gauges, ignition and controls, checked for traffic in the pattern and gathered our composure. Pushing the T-handle throttle to the stop, we watched the runway centerline start scrolling under our wheels. The engine noise was robust, and headphones definitely helped. At 65 mph, we eased back on the stick and "Experimental 62785" left the tarmac on its maiden voyage into the atmosphere, climbing at just over 1000 fpm. Control response was brisk but not twitchy. And like any light vehicle, whether on land, sea or air, we felt more bumps than we would have in a heavier craft.

The Zodiac can be trimmed for hands-off straight and level flying, either with one or two aboard. Flying it solo, it showed an easy roll to the left. With a passenger on board, it flew dead straight.

We circled the field and set up our approach for landing. Because the Zodiac has no flaps, we had to come in with the nose higher than we are used to, something we acclimated ourselves to after two go-arounds. There are also no mixture, carb heat, gear or prop controls, so there's really nothing to do to prepare for landings—except to land. The Zodiac likes a little power on final, as it tends to settle quicker than conventional trainers when you chop back to idle. Touching down on the main wheels at 65 mph, you can hold the nose off almost forever by cranking back on the stick. Eventually, it drops with a light kiss. Touchdown speed ideally should be more like 60 mph, but, hey, we were just getting the hang of it.

Back on the ground, we pulled the cowl and checked for leaks or anything amiss. Everything was tight. One change we did make was to relocate the oil cooler from inside the cowl to below it for a better shot at the airstream. This lowered the oil temp to a more desirable operating level.

After a few more landings to get the feel of it, we stayed up for a while. The plane is required by FAA regulations to fly 40 hours within a 25-mile radius before venturing cross-country. After sightseeing all of the farmland and livestock in our assigned test area, we throttled back to check out slow flight and stall characteristics. The Zodiac churned along at 60 mph, and mushed out at 53 mph with no surprises. Full tilt, we achieved an indicated airspeed of 125 mph. Pulling the prop and resetting the pitch on the bench with a protractor is a trial-and-error process that probably could have squeezed a few extra mph out of the package. But we were in no hurry to get anywhere now, mainly because we had no place to go.

Building a kitplane is a great experience. The process encourages thinking and creativity—it's more than just inserting tab A into slot B. What we ended up with was a truly personal airplane, so simple in nature that it might coax a condescending smile from the lips of seasoned pilots who fly highly sophisticated aircraft. Still, we can't help but step back and be in awe of this marvelous little machine that soars with eagles and promises us volumes of adventure. **PM**

SOURCE LIST

Aircraft kit:
Zenith Aircraft Co.
Mexico Memorial Airport
Mexico, MO 65265-0650
573/581-9000; fax: 583/581-0111;
e-mail: www.zenithair.com

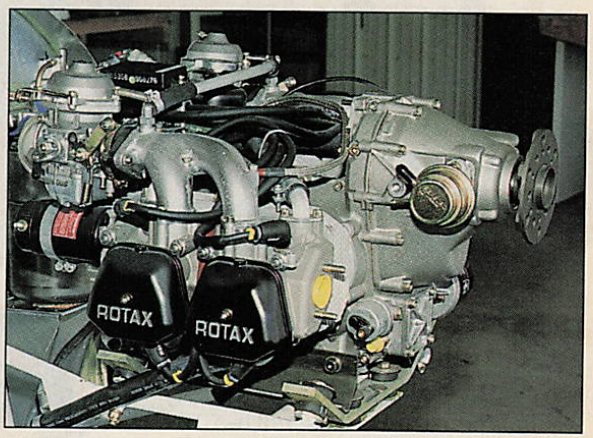
Instrument panel fabrication:
Gulf Coast Avionics
4243 N. Westshore Blvd.
Tampa International Airport
Tampa, FL 33614; 800-474-9714

Rotax engines:
Lockwood Aviation Inc.
280 Hendricks Way
Sebring, FL 33870; 941/655-5100

Avionics:
Allied Signal Aerospace, Bendix/King
400 N. Rogers Rd.
Olathe, KS 66062; 913/768-3000

Handheld GPS:
Magellan Systems Corp.
960 Overland Ct.
San Dimas, CA 91773; 909/394-5000

Magellan SkyStar handheld GPS (left) is the slickest of new-generation units. FAA rep Earl Neff (below right) checks our workmanship for Airworthiness Certificate.



Rotax 912 (above) is an aircraft engine from the ground up, rather than just a converted powerplant. It produces 80 hp from 74 cu. in. and uses twin altitude-compensating carburetors and dual electronic ignition. Integral reduction gear (large unit at front) mounts round-shaped mechanical fuel pump. Vacuum pump for gyro instruments will attach to rear of reduction gear.

SPY ART

Cold War weaponry returns in a secret agent's artwork.

BY JIM WILSON, Science/Technology Editor
PM Photos by Kenneth Garrett

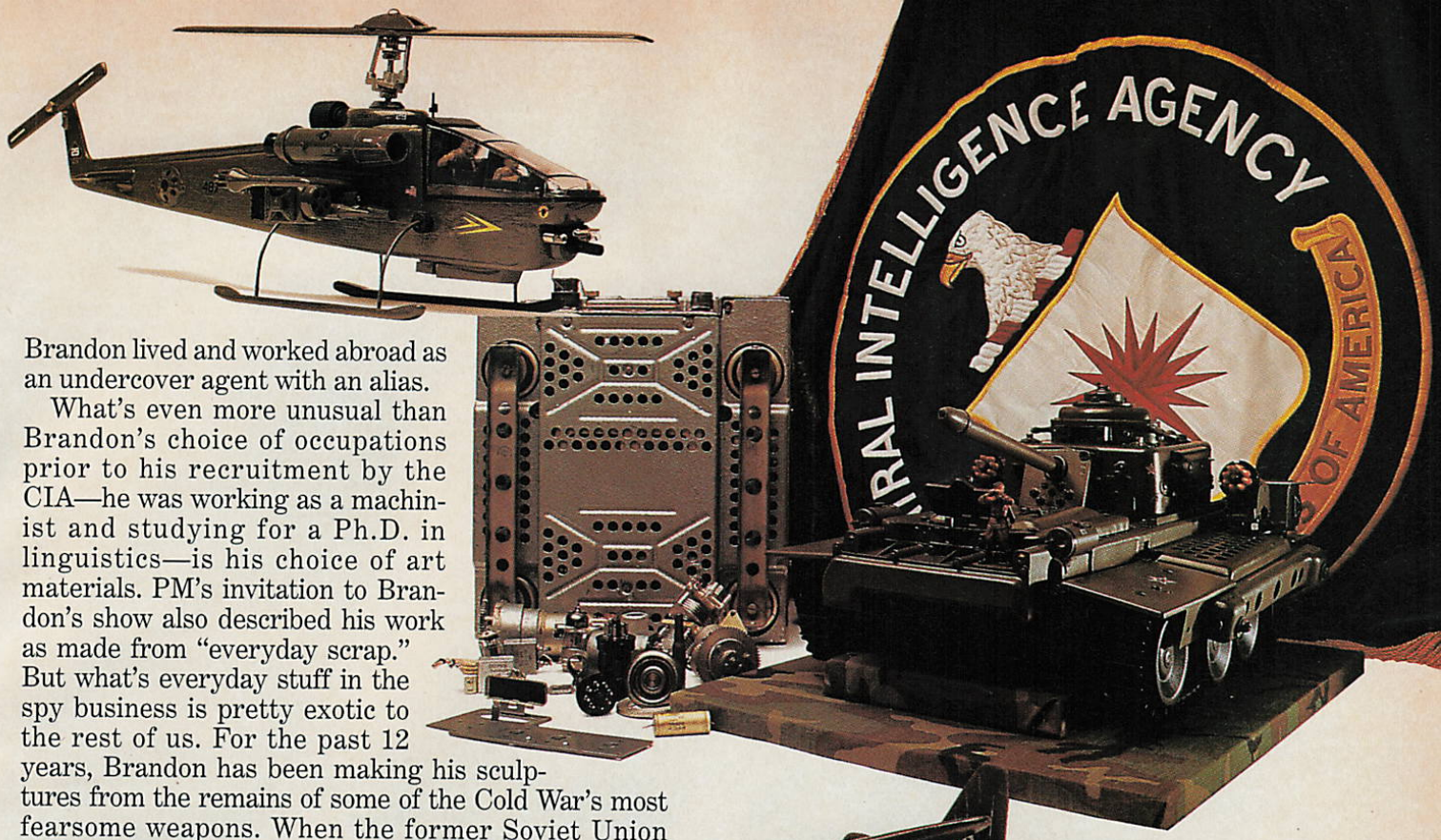
● Art show openings are customarily exclusive affairs, hence invitations are usually hard to come by. But we doubt there has ever been a debut quite as exclusive as the one for "Junkanimation." The price of admission was a top-secret security clearance.

On a pleasant spring day shortly after the opening, the CIA invited POPULAR MECHANICS to its headquarters in the Virginia countryside to meet an intriguing artist and see his work.

The invitation modestly described the exhibit as "a display of military modeling and art deco sculpting." After passing through two security checkpoints—the last beneath the watchful gaze of a bronze statue of World War II espionage legend "Wild Bill" Donovan, the "father of the CIA"—we learned there was nothing ordinary about either the artist or his choice of materials.

For 24 years, artist Charles "Chase" Brandon had a day job with the CIA. If you want a 3-letter crossword puzzle entry that sums up his job, try s-p-y.

MAGNIFYING GLASS PHOTO BY A. GREG ALTER



Brandon lived and worked abroad as an undercover agent with an alias.

What's even more unusual than Brandon's choice of occupations prior to his recruitment by the CIA—he was working as a machinist and studying for a Ph.D. in linguistics—is his choice of art materials. PM's invitation to Brandon's show also described his work as made from "everyday scrap." But what's everyday stuff in the spy business is pretty exotic to the rest of us. For the past 12 years, Brandon has been making his sculptures from the remains of some of the Cold War's most fearsome weapons. When the former Soviet Union collapsed, the CIA decided it was okay for his collection to come out of the cold.

Besides being just plain fun to look at, Brandon's sculptures made from "found objects" provide insights into Soviet warfare capabilities. In many of his pieces, Brandon displays a sampling of the source material next to the finished work. Shell casings from spent cartridges, for example, reveal that Soviet ammunition makers had none of the quality-control problems that plagued the country's automobile industry.

The brains visible through the head of "Junkules" (top left, opposite page) provide a rare glimpse at the internal workings of the much vaunted MiG 21. Surprisingly, parts from the jet fighter's communications gear, which are intermixed with VCR parts, include old-fashioned vacuum tubes!

In addition to fashioning artwork from weapons, Brandon has made his own interpretations of U.S. and Soviet weapons, a sampling of which are shown on these pages.

Now that a new world order has apparently been established, Brandon—who is now living in the United States—is looking beyond military scrap for his inspiration and art supplies. In his workshop, a 1-liter soft-drink bottle becomes transformed into a blimp. "I see broken and scrapped items not as junked remains of something old and useless, but rather as precursors for creating something new and visually stimulating," he explained as he guided PM through the display inside CIA headquarters. "An ordinary thing looked at from a different angle can conjure a new and extraordinary image."

After making the rounds at various intelligence organizations in the Washington area, a "declassified" version of "Junkanimation" will be displayed at more public locations. **PM**

TURN OF THE

On-water testing with one boat and six props teaches a lesson about spinning your

BY JOHN WOOLDRIDGE

● Each year, hundreds of boaters spend countless thousands of dollars on machine-shop equipment and bolt-on gadgets in their quest to increase outboard horsepower. Yet the easiest and least expensive way to improve performance is to change propellers. Regardless of your rig's size, horsepower or application, the right prop can make the difference, whether you seek increased speed, better handling or more power.

Even if you're happy with your boat's performance, you and your family might participate in more than one watersport, and you may benefit from changing props. Fishing, cruising and waterskiing all place special demands and different loads on your engine. Choosing a prop with the correct pitch, diameter, rake, surface area and contour will keep your engine within factory-recommended wide-open throttle (WOT) rpm ratings. Besides, having more than one prop on board is cheap insurance and good common sense.

Whether you're interested in props with names like "chopper" or "cleaver," or if you just want to know the differences between sizes, materials and trade names, your dealer's an expert. But PM wanted to go beyond theory and show how different props can change boat performance, so we tested six props (on a single boat) that incorporate a variety of materials and designs, from the most basic to the technologically advanced.

Basic properties

Props are initially classified by numbers showing diameter and pitch. Diameter is the width of a circular

SCREW

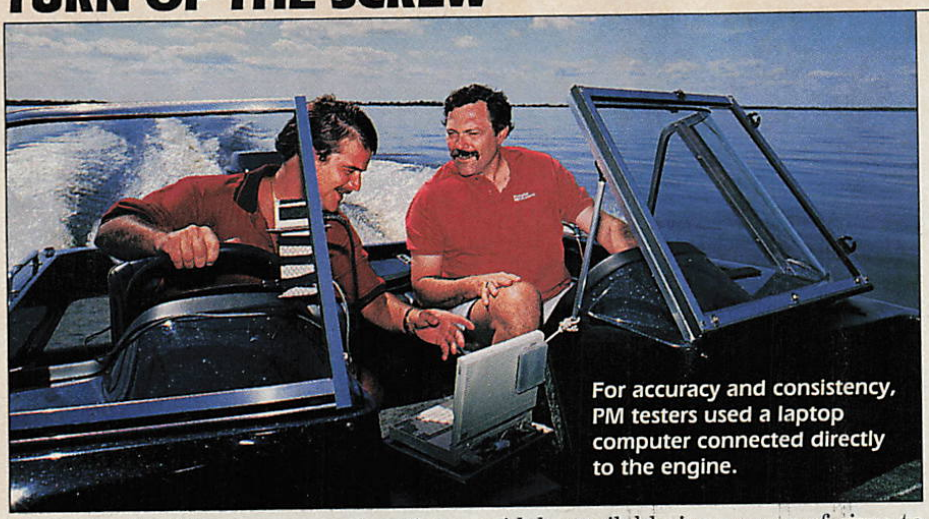
wheels on the water.

column of water flowing off the face of the prop. Pitch is the number of inches your boat and motor should move forward in the water when that prop makes one complete revolution. A 13 × 21 prop has a 13-in. diameter and a 21-in. pitch. You'll get optimum performance when pitch and diameter allow your motor to operate within the factory-recommended full-throttle rpm range. That calls for a careful match between engine power, gross weight and the intended use of the boat.

Generally, the heavier the boat, the lower the prop pitch required. The same horsepower motor on a lighter boat needs a higher pitched prop to give it more speed and efficiency in its use of the engine rpm. Assuming you use the same engine and boat for three different sports, a 13 × 21 prop might be ideal for general cruising, while a 13 × 23 would be more suitable for lightly loaded fishing trips, with a 13 × 19 just right for waterskiing.

Just to make things a bit more confusing, there are two types of pitch: constant and progressive. On a constant-pitch prop, the pitch stays the same across the face of the blade, while on a progressive-pitch screw it starts low and increases across the face of the blade, making the prop appear twisted. Built for high-speed and high-rpm applications, including those instances when the prop is breaking the water's surface, progressive-pitch props are used in virtually all outboard applications. The number designated on a progressive-pitch prop represents the average pitch.

While progressive pitch gives you some compromise



For accuracy and consistency, PM testers used a laptop computer connected directly to the engine.

in the tradeoff between acceleration and top end, it's still a fixed blade. A variable-pitch propeller allows your boat to shift gears like a car, since it's designed to maintain a low pitch angle during initial acceleration, then shift to a higher pitch angle in the higher rpm ranges. Some boaters don't like the variable-pitch because it's more expensive and just as vulnerable to damage, while others say their high initial cost can be balanced against the cost of carrying a second prop for different activities.

Two other considerations, blade rake and cup, also affect your propeller performance. Blade rake describes the angle of the blade to the hub. A perpendicular blade has no rake, whereas a high-performance blade may have 20 or more degrees of slant aft to decrease blade drag through the water. Cup is a lip or sharp contour near the trailing edge of the blade that keeps water on the blade longer for high-speed applications.

In recent years, 4- and 5-blade props have become popular because they suppress vibration and improve acceleration by putting more blade area in the water, especially when the prop is breaking the surface. They can also provide more bow lift for added speed.

Material matters

The thinner the blade's edges, the less energy required to spin it. But thickness varies based on a number of factors, including the material used in building the prop, which plays a key role in helping the blades achieve and hold the desired shape.

Because of its low cost and light weight, aluminum dominates the market. For low- or high-horsepower applications, aluminum props are the industry standard and widely available in a range of sizes to suit virtually every application. Dings and nicks can be repaired relatively easily, but corrosion resistance is dependent on careful monitoring of the prop's coating. Keeping an aluminum prop touched up with paint will result in years of additional service.

For strength and durability, nothing touches stainless steel. Stainless-steel props can have thinner blades than aluminum props because they're five times stronger, making them desirable for heavy or high-speed applications. Those who want improved acceleration and top-end speed, along with increased trimming and holding ability, select stainless-steel props that are application- and engine-specific solutions for optimum boating performance and pleasure.

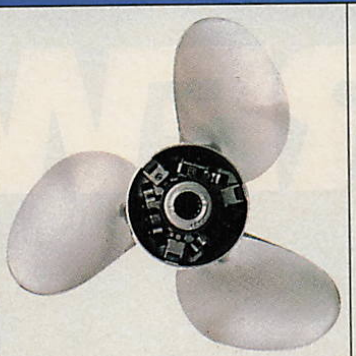
You hear a great deal about plastic props these days. You can't find a more corrosion-resistant prop material, and it weighs about half as much as a comparable aluminum wheel and costs significantly less. Some earlier plastic props suffered from distortion under heavy load, making them far less efficient at transmitting torque than their metal counterparts. More recent plastic props are said to be stiffer, which would make them excellent spares to carry aboard. Plastic props are commonly used for low-horsepower gasoline motors such as "kickers" or electric trolling motors.

Procedures

With the help of Ranger Boats, Mercury Outboards and the engineers at Mercury Marine Propeller Co. (MMPC), we witnessed how much of an improvement changing props could offer. Our test boat was a Ranger 692VS from the formidable Fisherman series, with Mercury's 175 EFI V6 on the transom providing the push. Our prop selection, with four props from MMPC and two interesting outsiders, included: MMPC Trophy, 13¾ × 21, 4-blade, stainless steel; MMPC Black Max, 14¼ × 21, 3-blade, aluminum; MMPC Vengeance, 13¾ × 21, 3-blade, stainless steel; MMPC Tempest, 14¾ × 23, 3-blade, stainless steel; Gil Marine Six-Gun, 14½ × 21, 6-blade, plastic; and Aerostar Switch Blade Pro, 14½ × 22, 3-blade, stainless steel, variable pitch. Using replaceable blades swung by gear-driving counterweights mounted inside the hub, this last prop automatically switches from a 15-in. pitch to the final 22-in. pitch at the rpm you select.

TEST PARAMETERS

Each test was conducted with full fuel, the same test gear package and the same two people in the boat (designated Light). Then, we added 400 pounds of shot in appropriate locations for a second series of tests (designated +400 Lb.). All results are averages of multiple runs.



MODEL	SWITCH BLADE PRO	BLACK MAX
Price	$949	$160
Diameter × Pitch, Material	14½ × 22, stainless steel	14½ × 21, aluminum
23¼" Transom Ht. (Light) Top Speed & Rpm	54.9@5560	51.6@5850
23¼" Transom Ht. (Light) 0-20/0-30 Sec.	2.6/4.6	3.2/5.0
23¼" Transom Ht. (Light) Rpm @ 40 Mph	4140	4455
23¼" Transom Ht. (+400 Lb.) Top Speed & Rpm	52.5@5450	50.4@5665
23¼" Transom Ht. (+400 Lb.) 0-20/0-30 Sec.	3.2/5.9	4.1/6.4
23¼" Transom Ht. (+400 Lb.) Rpm @ 40 Mph	4200	4420
24¾" Transom Ht. (Light) Top Speed & Rpm	55.2@5740	49.5@6130

A prop can affect the boat's attitude. Here, the bow seems to squat a little.

We conducted test runs on the Fox River in Oshkosh, Wisconsin. We measured top speed, acceleration times from a standstill to 20 mph and from a standstill to 30 mph, and recorded rpm readings at 40 mph to see which props were most efficient and produced the least engine wear (see Test Parameters below). The engine was mounted at a transom height of 23¼ in., placing the cavitation plate 3¼ in. from the boat's bottom.

Results

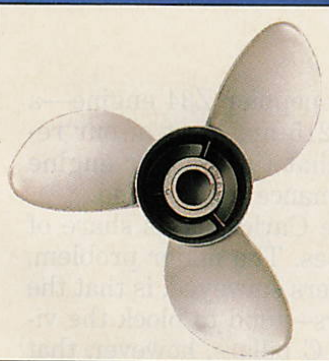
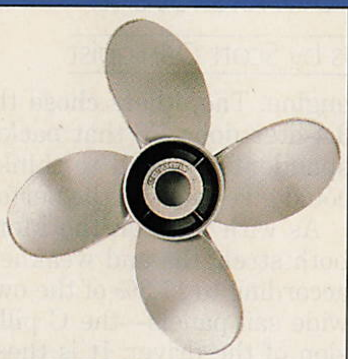
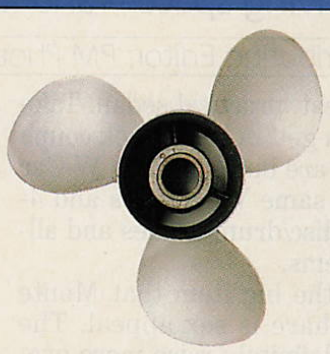
King of the high-speed tests was the Tempest, although it proved to be less than stellar in the timed 0-20-mph and 0-30-mph acceleration runs. In our fixed-speed tests, which measure rpm and overall efficiency, it was the clear winner. Second across the top-speed finish line was the Trophy, but it only finished in the middle of the fleet for acceleration and efficiency.

Aerostar's Switch Blade Pro barely edged out the Vengeance for third place in high-speed honors, but because of its ability to start out in a lower pitch, it shined brightly in the acceleration portions of our test. The aluminum Black Max provided a baseline for comparison with all of the other stainless-steel props. Gil Marine's Six-Gun was well off the pace in all categories except price, yet it still produced respectable speeds.

When testing was complete at the 23¼-in. transom height, we opted to remove the additional weight, raise the engine to a 24¾-in. transom height and retest all the props for top speed. Within recommended ranges, this trick can reduce drag by lifting more of the lower unit out of the water, but it is not a universal solution. Interestingly, the three fastest props all showed slight gains in top speed without changing ranking, while all the other props were slower.

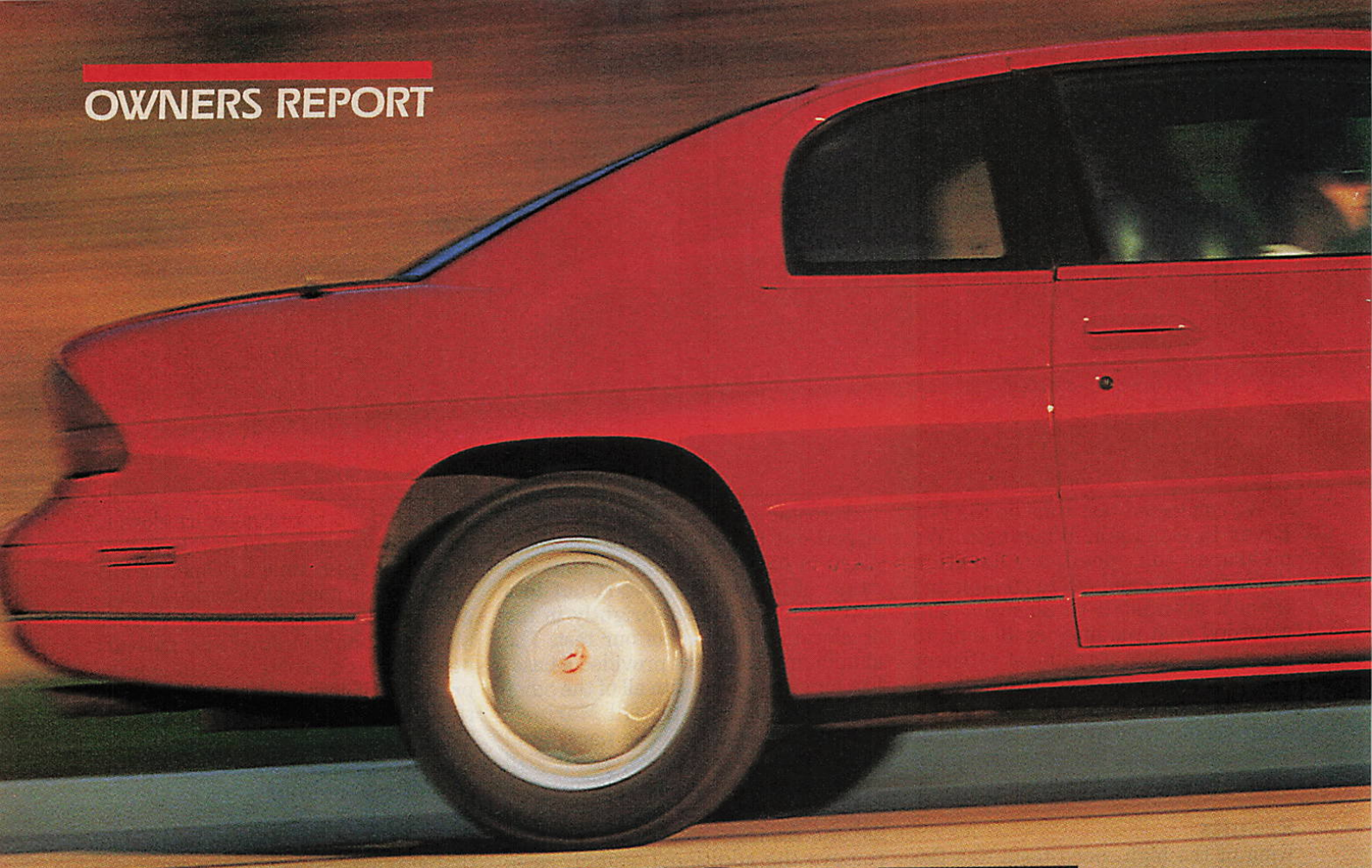
Whichever prop you decide to buy, inspect it from time to time, or any time you feel unusual vibration or sluggishness. A badly nicked or warped blade can spoil an otherwise pleasant boat ride and create serious engine problems if left unattended. Change the prop if the vibration is serious. The damaged prop may be repairable, but that must be weighed against the cost of repair, which might make a new prop more cost-effective.

When choosing a prop, remember that your engine will last longer if you pay attention to proper blade selection and maintain it carefully. If you have any questions at all, check with your dealer. He can give you advice on the right prop or props for your rig and your favorite sports, and he knows that the key to having fun on the water requires only a simple turn of the screw. **PM**

	TEMPEST	TROPHY	VENGEANCE	SIX-GUN
	$575	$595	$475	$105
	14¾ × 23, stainless steel	13¾ × 21, stainless steel	13¾ × 21, stainless steel	14½ × 21, plastic
	56.1@5395	55.3@5705	54.5@5595	45.2@5510
	4.0/6.3	3.7/5.9	3.6/5.7	3.9/6.4
	3900	4215	4175	4340
	53.6@5240	53.1@5650	52.2@5340	43.5@5425
	5.1/7.8	4.7/7.3	4.7/7.3	5.1/8.1
	3975	4280	4225	4505
	56.4@5505	55.4@5840	50.8@5920	44.9@5610

PM PHOTOS BY BRIAN KOSOFF



CHEVROLET MONTE CARLO

It's Chevy's personal driving space—and its owners love it.

BY MICHAEL LAMM, Contributing Editor; PM Photos by Scott Dahlquist

● The Chevy Lumina is a great, practical sedan. Take two doors off and what do you get? A sexy, sleek coupe called the Monte Carlo. Both are built on GM's W-Car platform, and both offer the same V6 engines and 4-speed automatic transaxles, disc/drum brakes and all-independent suspension systems.

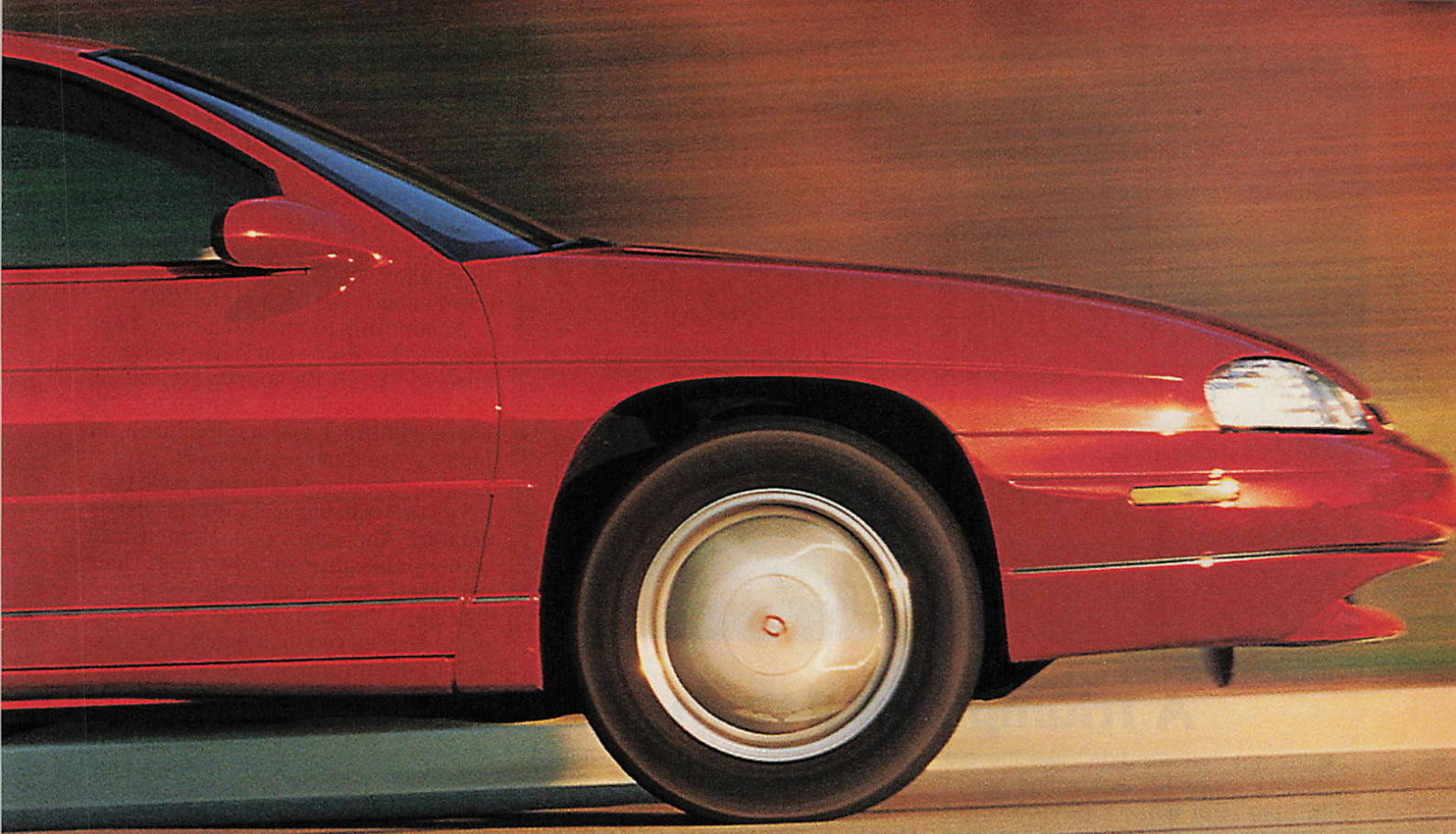
According to our survey, the big item that Monte Carlo and Lumina do not share is sex appeal. The Monte Carlo's swoopy lines definitely raise more eyebrows than the more sedately styled Lumina.

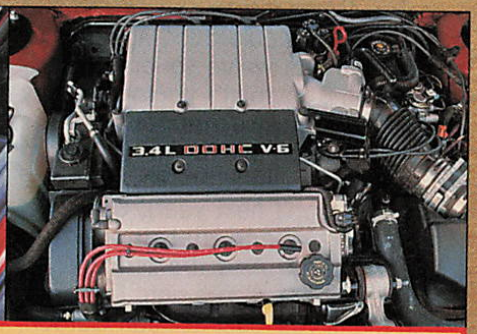
The Monte Carlo's sensuous styling seduced the majority of its purchasers. A full 78.3% of Monte Carlo buyers we surveyed cited styling as the primary reason for their decision. "Love at first sight" is the way a Wisconsin student put it. Not only is the Monte Carlo designed to look good, it inherits a strong reputation for value from the Lumina. Price/value was the second most-common reason for buying the Monte Carlo, followed by good experiences with Chevrolet products.

In addition to sporty appearance, many Monte Carlo buyers shopped for power and performance. Interestingly enough, two-thirds of Monte Carlo buyers chose the smaller 3.1-liter 160-hp pushrod V6 engine. The others chose the peppier Z34 engine—a 3.4-liter dohc V6 that packs 215 hp. Most of our respondents seemed to think that the smaller engine could give them all the performance they needed.

As with any car, the Monte Carlo has its share of both strengths and weaknesses. The major problem, according to 17.3% of the owners surveyed, is that the wide sail panels—the C pillars—tend to block the vision of the driver. It is these C pillars, however, that add to the neato looks of the Monte. A couple of complaints were logged about road and engine noise, but a Wisconsin architect praised the car as "soooo quiet." Finally, a small number of Monte Carlo owners had problems with raspy steering columns and dashboard rattles. However, these owners agreed that the Monte Carlo's strong points outweigh its problems.

Chevrolet made sure that, like the Lumina, the Monte Carlo would be a value leader. The base Monte Carlo LS comes with an unusual amount of goodies for around $17,500. That includes standard ABS, a 4-speed automatic, all-independent suspension with front and rear stabilizer bars, dual airbags, air conditioning, a split bench seat, power windows, door locks

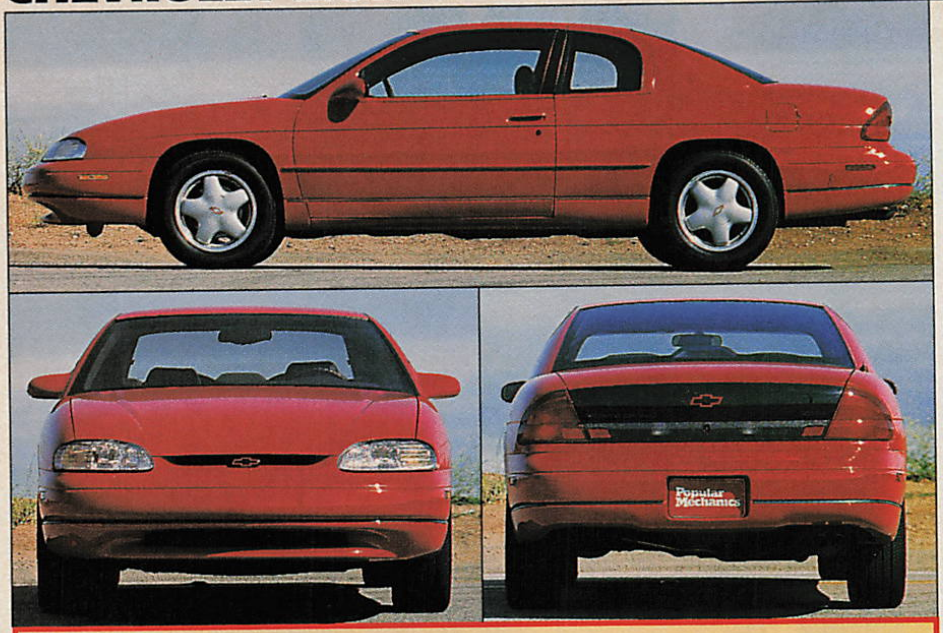




SUMMARY OF CHEVROLET MONTE CARLO OWNERS REPORTS*

Total miles driven	**1,763,547**
Average miles driven	**5546**
Purchase price:	
Average	$18,456
Range	$15,000-$22,000
Model choices:	
LS	71.2%
Z34	28.8
Options/Accessories:	
Antilock brakes	100.0%
Cruise control	95.4
Alloy wheels	86.8
Bucket seats	86.0
Premium sound system	78.4
6-way power driver's seat	61.3
Leather seat trim	29.4
Bench front seat	14.0
Why did you choose the Monte Carlo?	
Styling	78.3%
Price/value	20.7
Owned Chevys before	19.7
Handling	10.5
Power and performance	9.6
Comfort, ride qualities	8.3
Standard equipment	7.6
Avg. mpg, city/hwy:	
3.1-liter V6	20.5/26.7
3.4-liter V6	18.6/24.2
Specific likes:	
Styling	79.0%
Power and performance	38.6
Handling	35.9
Comfort	32.4
Ride qualities	22.1
Quietness	12.8
Specific dislikes:	
Poor rear vision	17.3%
No complaints	16.1
Noisier than expected	9.7
Shoulder harness	7.3
Poor fuel economy	6.0
Ride and comfort	4.8
Suggested changes:	
Better rear vision	14.5%
Add a V8 option	10.5
No changes	8.0
Greater quietness	6.0
Improve shoulder harness	5.5
Improve seating comfort	5.0
Rear-wheel drive	5.0
Engine power:	
Excellent	62.5%
Good	35.4
Fair	1.8
Poor	0.3
Handling:	
Excellent	73.8%
Good	23.7
Fair	2.5
Poor	0.0
Braking:	
Excellent	66.5%
Good	28.9
Fair	3.4
Poor	1.2
Overall performance:	
Excellent	69.7%
Good	28.7
Fair	1.6
Poor	0.0
Layout of controls:	
Excellent	69.9%
Good	28.0
Fair	1.9
Poor	0.3
Instrumentation:	
Excellent	66.4%
Good	30.5
Fair	2.2
Poor	0.9
Driver sightlines:	
Excellent	42.9%
Good	38.5
Fair	13.7
Poor	5.0
Overall convenience:	
Excellent	59.7%
Good	39.3
Fair	2.3
Poor	0.7
Workmanship opinion:	
Excellent	66.7%
Good	30.5
Fair	2.2
Poor	0.6
Front-seat comfort:	
Excellent	69.9%
Good	26.1
Fair	3.1
Poor	0.9
Rear-seat comfort:	
Excellent	43.3%
Good	48.3
Fair	7.7
Poor	0.7
Any mechanical trouble?	
No	59.5%
Yes	40.5
What type of trouble?	
Wiper motor	10.6%
Chipped/marred paint	8.3
Brake noise	5.3
Electrical	5.3
Steering wheel noise	5.3
Transmission	5.3
Trim problems	4.5
Water and air leaks	4.5
Repair it yourself?	
No	98.5%
Yes	1.5
Dealer repairs satisfactory?	
Yes	77.3%
No	22.7
Dealer service opinion:	
Excellent	53.9%
Good	36.4
Fair	8.3
Poor	1.3
Dealer sales policy:	
Excellent	54.7%
Good	37.3
Fair	7.1
Poor	0.9
Number of vehicles owned:	
This vehicle only	25.3%
Two vehicles	42.0
Three vehicles	21.9
Four or more	10.8
Principal driver:	
Female	58.9%
Male	28.5
Both equally	12.7
Age distribution of owners:	
Under 30	19.0%
30-49	49.0
50-plus	31.9
Based on your experiences, would you buy a Monte Carlo if you had it to do over again?	
Yes	69.3%
Maybe	25.4
No	5.3

* Percentages might not equal 100% due to rounding or insufficient data.



EDITORS REPORT

A Triumphant Return

● It's not that we didn't like the old Lumina coupe—it was a fine car in its time. But when Chevrolet first showed us its replacement, we smiled. When it was announced that the new car would once again carry the name that we've so long associated with Chevrolet's personal/luxury sporty coupe, we grinned. Call us traditionalists, but as long as Ford has a car called the Thunderbird (which it won't next year), Chevrolet should have one that answers to Monte Carlo. And the current car answers that call in a right fine manner, thank you. Just ask Jeff Gordon, Terry Labonte or Dale Earnhardt.

But the current Monte Carlo is much more than the ride of Winston Cup champs. It's the ride of choice for thousands of folks who want a sexy, comfortable, roomy, stylish and very competent 2-door that happens to have a back seat that has room for full-size adults.

No one really can argue that a coupe—any coupe—is primarily a single- or dual-occupant vehicle. If you have people climbing into and out of the back seat with great frequency, well then you ought to have a vehicle that has doors to that back seat. But the truth is, most of us find a 2-door car to be sexier than a 4-door. And many of us want a car that is as sexy-looking as it can be—witness the fact that nearly 80% of our respondents singled out the Monte Carlo's good looks as their reason for choosing the car. But the truth is, there are many occasions when we do need to situate other passengers in the back seat of the car. Hey, there are even times when we need to carry more than our usual one passenger, along with copious amounts of stuff in the trunk.

And those are the times that the Monte Carlo shines particularly brightly. This car is not only based on the same platform as the popular Lumina family sedan, it shares suspensions, drivetrains and essential dimensions such as wheelbase, track, width and length. The Monte Carlo also boasts the Lumina's cavernous 15.7-cu.-ft. trunk. It's a safe bet, then, that the Monte Carlo has about as much room inside its passenger compartment as does the Lumina sedan. That's a whole lot. The reality of it is that this Chevrolet is one very roomy coupe.

It's also a genteel sort of coupe, the way the Monte Carlo has always been. This is not a hard-edged, take-no-prisoners wheeled rocket. Chevy's Camaro performs that duty quite admirably for the carmaker. The Monte Carlo's performance is acceptable for around-town cruising and looking nice when rolling into the country club. But unlike our respondents, we feel that there's not much else in the line of go-power from the base 3.1-liter V6 engine. We definitely prefer the Z34 version with its additional 55 hp. With the dohc 3.4-liter and tauter suspension, acceleration is brisk and handling is crisper than otherwise.

In fact, when the Monte Carlo is in its sportier trim, it's a fun ride—maybe not a Corvette kind of fun, but a civilized, surprise-the-geek-in-his-imported-sport-sedan kind of fun. If you don't believe that the Monte Carlo can be a fun drive, why don't you just ask Jeff, Terry or Dale.

—Don Chaikin

and mirrors, tilt wheel, AM/FM cassette stereo, intermittent wipers, convenience light group and a tachometer. For about $2500 more, the base Z34 comes with the 215-hp V6, a console, keyless entry, cruise control, bucket seats, handling suspension and 16-in. alloy wheels. The rear seats fold down in both the LS and the Z34.

According to the owners interviewed, the Monte Carlo has performance to match its sporty styling. A Tennessee engineer commented, "It has a solid feel and handles well on highways and mountain roads."

With handling, value and style covered, the last big item on the list is comfort. And once again, Monte Carlo owners are quick to assert that their car has a very thoughtfully designed interior. The instrument panel and controls received high marks for their driver-friendliness and simplicity. The overall comfort of the car was praised, too. A Florida electrician remarked, "It's very comfortable on long trips. I don't get tired riding in it. We drove 6 hours straight to Atlanta and the trip was great." A Florida machine operator said, "The seats provide good back support, the car rides like a dream, and at idle you can't tell the engine's running." Even the Monte Carlo's rear seat got respectable reviews. "Plenty of room back there for our two kids," an Ohio recruiter said.

Our survey indicates that the Monte Carlo achieves its high satisfaction rate by being versatile enough to please people on many levels. For some, the car's appearance is important. "I've had at least 20 strangers come up and ask me how I like my Monte Carlo," a Minnesota credit manager remarked. "Most had owned Montes years before and really liked theirs. This car certainly catches people's attention." A Nebraska policeman echoed the credit manager's glowingly positive opinion with, "Very enjoyable to drive, and we've gotten more compliments on this car than any we've ever owned."

Quality is one of the supreme concerns of other owners in our survey, and the Monte Carlo is careful to please here, too. A California airman stated, "Overall, the car's built right. Paint is flawless, and I haven't had any real problems of any kind." A Tennessee factory worker added, "I've owned Monte Carlos before, and from past experience I'd say this is one of the best-built cars Chevrolet has produced in a long time."

Chevy's combination of style, quality and value in the reintroduced Monte Carlo is excellent, and it is bound to find a place in the hearts of many drivers. PM

SHOP PROJECT

Handmade Hand Plane

How to make a small hand plane for precise trimming and surfacing.

TEXT AND PHOTOS BY ROSARIO CAPOTOSTO, Contributing Editor

● While there are many custom fixtures, jigs and small tools that you can make for your shop, few offer the continuous reward and satisfaction of a handmade wooden plane. Here's a tool that you'll use on nearly every project you complete. And even when it's on the shelf, it's a constant reminder of quality craftsmanship and woodworking tradition.

Our small wooden plane is specially designed for one-handed operation. Unlike a conventional steel block plane, though, we've set the cutter angle closer to that found on standard bench planes. The larger angle makes our version more like a miniature smooth plane and the tool is less prone to tearout when working along the grain.

The real difference, though, is in the wooden body. Shaped to fit the palm of your hand with finger grips on the sides, this little plane is a joy to hold and use. Equipped with a sharp plane iron, it produces nearly transparent shavings and leaves the wood silky smooth.

The body of our plane is Honduras mahogany, and its sole is maple. While there are many replacement plane irons available through mail-order catalogs, we equipped our tool with a top-quality Hock handmade cutter. This high-carbon tool-steel blade holds a very sharp edge, and its 3/16-in. thickness resists chatter. The plane iron comes with its own chip breaker and we used a knurled brass screw to hold the cutter in place. (For details on suppliers, see the Miscellaneous Hardware Source List on page 82.)

Constructing The Body

While wooden plane bodies were traditionally made by cutting the blade throat through a solid block of wood, a laminated design is simpler to make and just as effective. With this method, angled core body segments are sandwiched between sidepieces to create the cutter throat.

Begin the body by cutting a piece of 1¾-in.-thick mahogany stock to 3¾ in. wide and 15 in. long. Joint one edge square and glue a ¼ × 1¾ × 15-in. piece of maple to that edge. Use a brad driven near each end to keep the strip in place while clamping. After the glue has dried, use a jointer, thickness planer or hand plane to reduce the blank to 1⁹⁄₁₆ in. thick (Photo 1).

Mark the angled cutlines following the "Cutting Core Pieces" diagram on page 83. Then, attach an auxiliary fence to your table-saw miter gauge. Set the gauge for the first cut, align the stock with the blade and clamp it to the miter-gauge guide fence to prevent the piece from shifting during the cut (Photo 2).

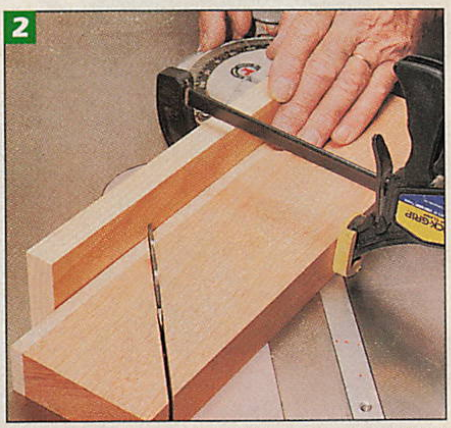
After the first cut has been made, reset the miter gauge and make the second cut. Follow this cut by sawing off the long section reserved for the sides of the body, and then make the fourth angled cut to form the shoulder piece (Photo 3).

To cut the body sides, first rip the blank to 3⅜ in. wide. Then, set the table-saw fence for a ¼-in. rip, and set the blade height to about 1¾ in.—slightly more than half the stock width. Then, rip the ¼-in.-thick blank by sawing from each edge. Use an L-shaped pushstick taped to the work for the second half of the cut (Photo 4).

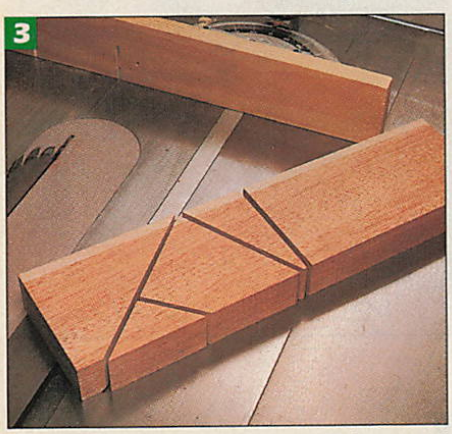
MISCELLANEOUS HARDWARE SOURCE LIST

- 1⅛" No. 05E0111 brass smooth-insert knob: Lee Valley Tools Ltd., P.O. Box 1780, Ogdensburg, NY 13669.
- 1½" No. 53.001.6 Hock plane iron with chip breaker: The Japan Woodworker, 1731 Clement Ave., Alameda, CA 94501.
- Brass strip, ⅛"-dia. brass rod, 10-24 threaded insert, ¼"-20 threaded insert, ¼"-20 × ¾" knurled brass screw: Armor Crafts, P.O. Box 445, East Northport, NY 11731.

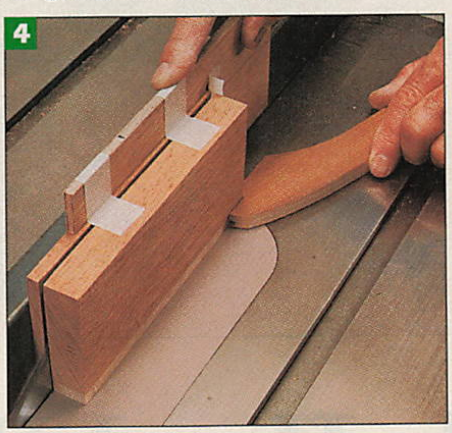
After gluing maple sole to mahogany, use a jointer to flatten faces of workpiece. Bring stock to 1⁹⁄₁₆-in. thickness.



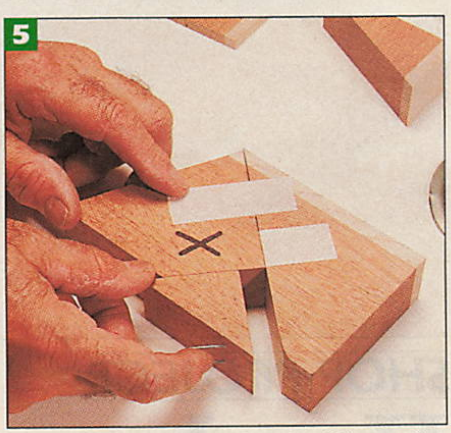
Clamp workpiece to miter gauge auxiliary fence to prevent shifting when making core cuts. Here, first cut is made.



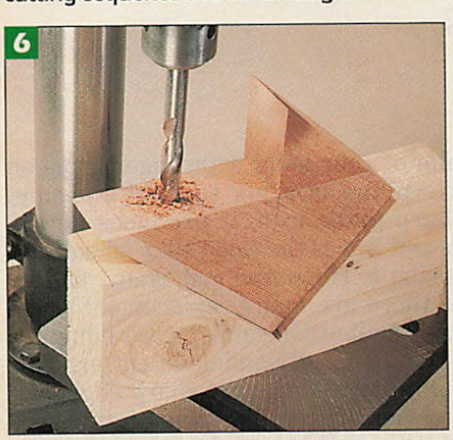
Make four cuts to produce core pieces and blank for resawing sidepieces. Follow cutting sequence shown in diagram.



Resaw sidepieces by cutting from each edge of stock on table saw. L-shaped pushstick supports work safely.



Use waste core piece (marked X) to align core shoulder with rear block. Attach shoulder with glue and two small nails.

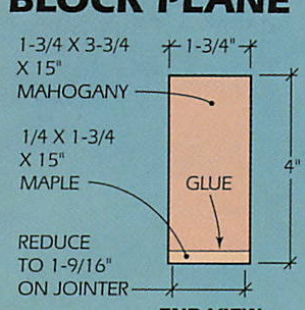


Make a 2 × 4 cradle to hold face of core block parallel to drill-press table. Bore the hole for the ¼-in.-20 threaded insert.

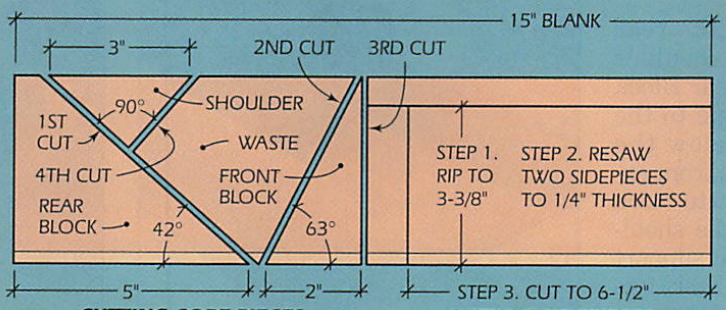
Use a headless bolt in drill-press chuck to install threaded insert in core block. Jammed nuts on bolt hold insert in place.

Use the plane iron to position the maple alignment boss on the core block. Attach the boss with glue and small brads.

BLOCK PLANE

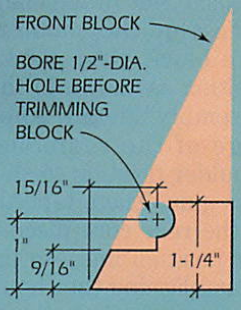


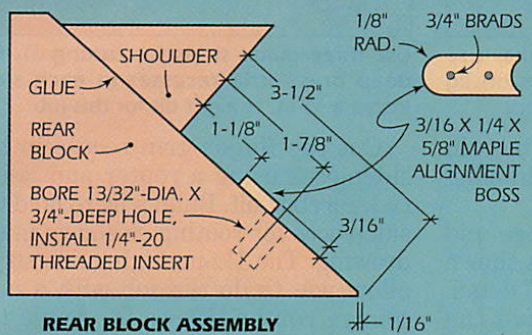
END VIEW



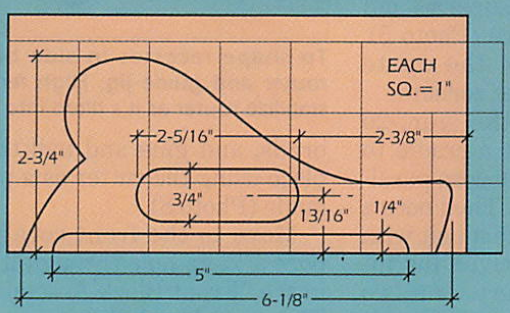
CUTTING CORE PIECES

CUTTING SIDEPIECES

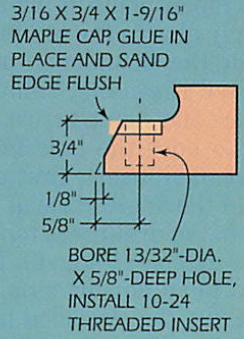




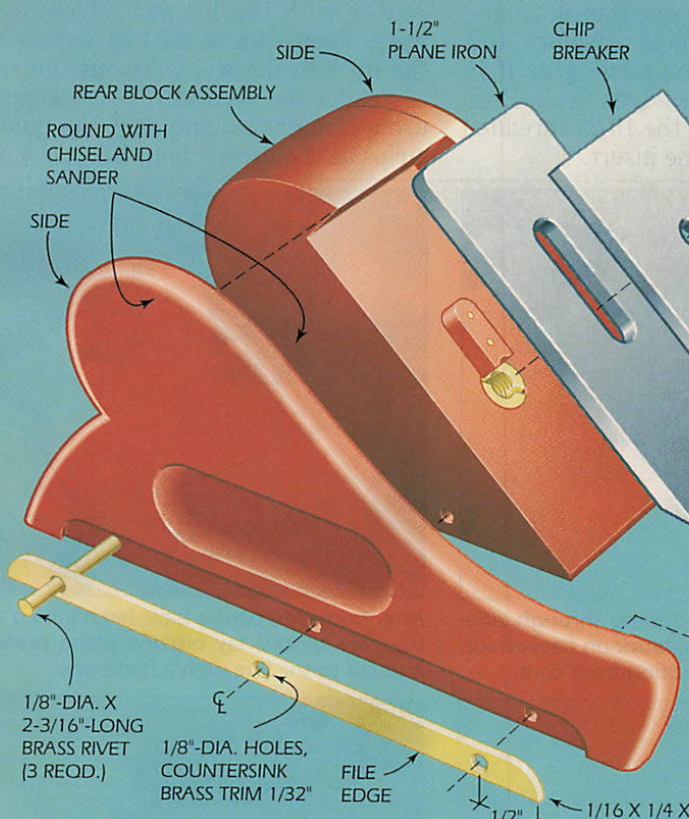
REAR BLOCK ASSEMBLY

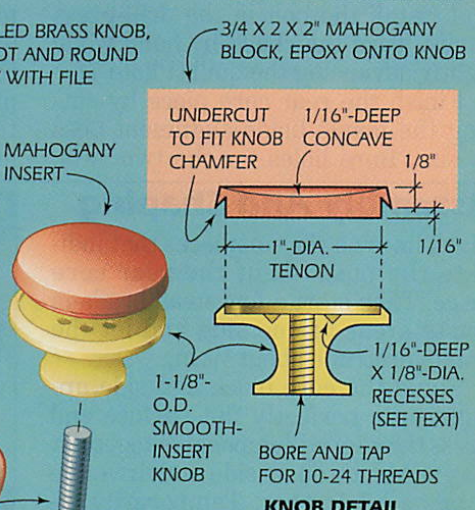


SIDE PATTERN

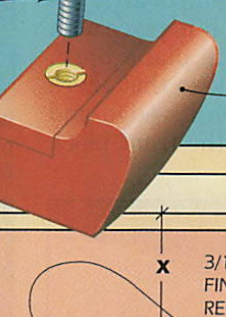


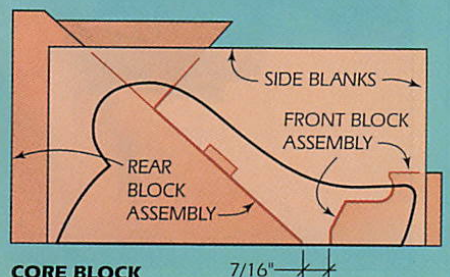
FRONT BLOCK ASSEMBLY




1/4"-20 X 3/4" KNURLED BRASS KNOB, CUT 1/16 X 1/16" SLOT AND ROUND OFF HEAD SLIGHTLY WITH FILE
3/4 X 2 X 2" MAHOGANY BLOCK, EPOXY ONTO KNOB
MAHOGANY INSERT
UNDERCUT TO FIT KNOB CHAMFER
1/16"-DEEP CONCAVE
1/8"
1"-DIA. TENON
1/16"
1-1/8"-O.D. SMOOTH-INSERT KNOB
1/16"-DEEP X 1/8"-DIA. RECESSES (SEE TEXT)
BORE AND TAP FOR 10-24 THREADS

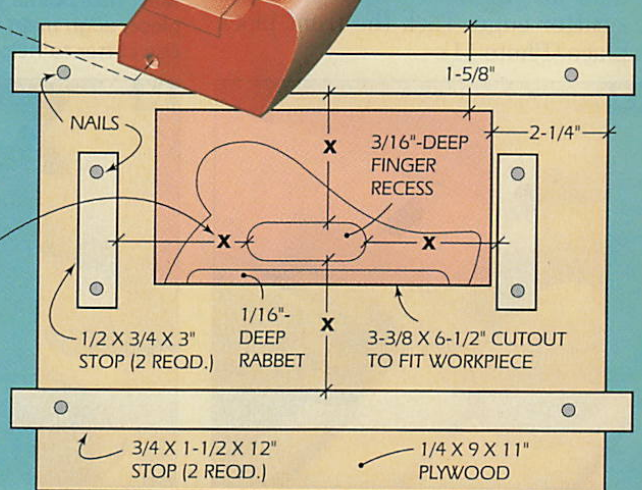
KNOB DETAIL





CORE BLOCK POSITIONS

X EQUALS DISTANCE FROM EDGE OF ROUTER BASE TO EDGE OF 3/8"-RAD. CORE BOX ROUTER BIT. RABBET FOR BRASS TRIM IS CUT USING SAME BASIC JIG. ADJUST STOPS ACCORDINGLY AND CUT WITH 1/2"-DIA. STRAIGHT BIT



JIG FOR ROUTING SIDE RECESSES AND RABBETS

PM TECHNICAL ART BY EUGENE THOMPSON

Resaw the second sidepiece from the opposite side of the blank.

To glue the shoulder to the rear core block, first mark the shoulder position as shown in the "Rear Block Assembly" detail. Apply tape to the edge of the rear block below the shoulder position to shield it from excess glue. Then, tape the waste block to the rear core piece—at the shoulder position line—to provide support when aligning the shoulder. Start two alignment nails in the shoulder piece, apply glue to the mating surfaces and slide the shoulder in place (Photo 5). Drive the nails, remove the waste block and clamp across the corners.

To bore the hole for the ¼-in.-20 threaded insert, first cut a cradle to hold the angled face of the core parallel to the drill-press table. Then bore a 13/32-in. hole (Photo 6). Use a bolt with the head cut off as a driver for installing the threaded insert. Jam two nuts on the bolt, twist on the insert and install the bolt in the drill-press chuck. Turn the chuck by hand while lightly advancing the quill (Photo 7).

Finish the rear core piece by cutting the maple blade-alignment boss to size. Bore holes for the two ¾-in. brads, and glue and nail the boss in place using the cutter as a positioning guide (Photo 8).

Move to the front core piece and bore a ½-in. hole through it as shown in the "Front Block Assembly" detail. Then cut the ledge to receive the maple cap and remove the remaining waste around the hole as shown. Cut the cap slightly oversize, glue it in place and sand the edges flush. Bore the 13/32-in. hole for the 10-24 threaded insert and install the insert.

To shape recesses in side blanks, use router and guide jig. High fences on jig stabilize router as it's tilted into work.

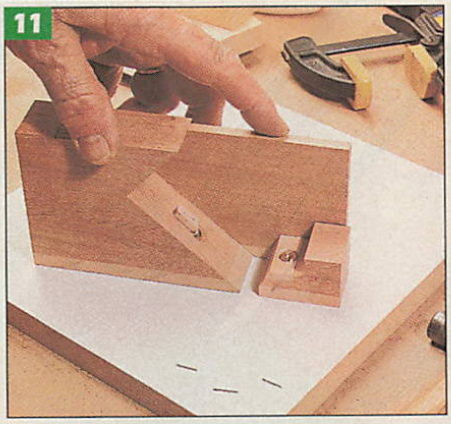
Use three guide strips for cutting 1/16-in.-deep brass-strip recesses in each side. Install a ½-in. straight bit for this job.

Cut the finger-grip recess in the sidepieces using a router and ⅜-in.-rad. corebox bit. Build a jig to hold the sidepieces for routing as shown in the drawing. The 1½-in.-high guide strips allow you to do the job with a nonplunge router (Photo 9). Angle the router with the bit away from the work. Then, turn on the tool and lower the bit into the work. To cut the recesses for the decorative brass strips, use a straight bit and shift the guide strips as required (Photo 10).

Assembly And Shaping

Mark lines on the sidepieces that indicate the position of the rear core piece. Then start a few small brads in waste areas of one side and let the points protrude about 1/16 in.

Stand the core block and side upright on a perfectly flat surface and press the aligned components together. Lay the block on its side and drive the brads a bit farther. Temporarily install the blade and lock it in place with its edge flush with the plane base. Position the front block so that there is a 1/16-in. gap between its edge and the cutter edge. Tack the front block in place (Photo 11).



With nail points protruding through sidepiece, align main core block on flat surface. Use cutter to help position front core.

After both side panels have been joined to the core blocks, lay out the plane profile and cut to the line with a band saw.

Use the end of a belt sander to smooth concave surfaces at front of plane. Disc sander handles convex surfaces.

Round the corners of the plane body with a sharp chisel. Then, move to a file and sandpaper for final smoothing.

Contour sander is useful for smoothing hard-to-reach areas such as the endgrain on the inside corner of the plane back.

Trace around the core blocks on the plane side. Then, separate the pieces, apply glue to the mating surfaces of the core pieces and side, assemble the parts and clamp. When the glue has dried, nail, glue and clamp the second sidepiece to the subassembly.

Lay out the body profile and cut the plane to shape on a band saw (Photo 12). Use a disc sander to smooth the saw marks on the convex portions of the body, and use a drum sander or belt sander to smooth the hollow areas (Photo 13).

Hand sand and file any areas you can't reach with the disc, drum or belt sander. Use a sharp chisel to round the edges (Photo 14) and finish smoothing with a file and sandpaper. Also, a contour sander is useful for smoothing the concave surfaces (Photo 15).

Final Touches

Cut the brass strips to size and shape, so they fit the recesses routed in the plane sides. Use a disc sander to shape the radii on the ends (Photo 16). To secure the strips, first roughen the back of each with 100-grit sandpaper. Then apply epoxy to the mating surfaces and tape the strips to the plane.

After the epoxy has cured, bore ⅛-in. holes through the plane for the rivets. Countersink the holes about 1/32 in. deep. Then, cut three pieces of ⅛-in.-dia. brass rod ⅛ in. longer than the plane width. Insert these pieces in the rivet holes so that they protrude 1/16 in. from each side. Then, back each rivet on a vise anvil or steel block and mushroom the rivet ends by hammering lightly (Photo 17). Belt sand the rivet heads and brass strips flush with the plane body (Photo 18).

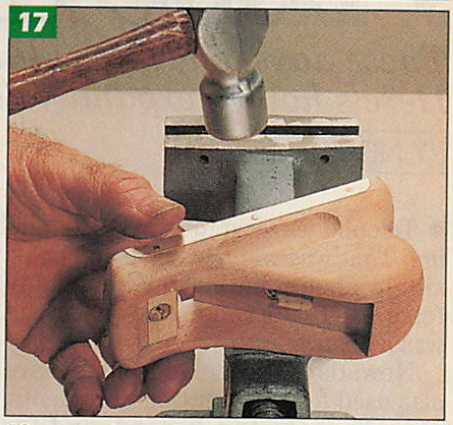
Begin the front knob by first making a ¾ × 2 × 2-in. mahogany block and then cutting the corners in preparation for turning on a lathe. Mount the blank between lathe centers and turn one face so it fits the surface of the smooth-insert knob as shown in the "Knob Detail." Bore a few shallow holes in the face of the knob to act as keys for the epoxy and secure the block to the knob.

When the epoxy has cured, use a drill press with a No. 25 bit to enlarge the existing hole in the knob (Photo 19). Then tap the new hole for a 10-24 thread. To finish the top of the knob, insert a 10-24 headless screw in the knob, mount the assembly in a lathe chuck and turn the wood to size and shape (Photo 20).

To complete the plane, use a hacksaw with doubled blades to cut a screwdriver slot across the head of the brass screw. Mount the screw in a lathe and use a file to smooth and round the top surface. Finally, use a water stone or oilstone to hone the edge of the plane iron (Photo 21).

To finish our plane, we applied a coat of Behlen's Solar Lux medium red mahogany stain followed by two coats of Deft Semi-Gloss Clear Wood Finish. Don't apply the finish directly on the plane sole. Rub each coat lightly with extra-fine (0000) steel wool and follow with paste wax buffed with a soft cloth.

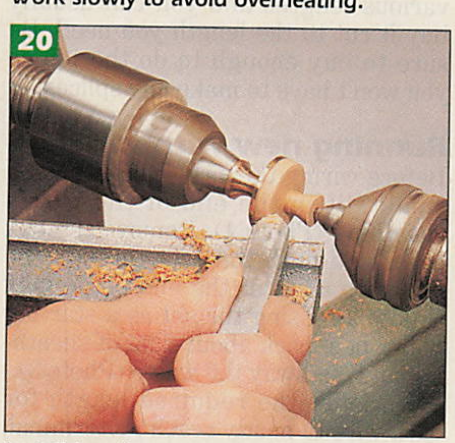
Use a disc sander to shape the round ends of the brass strips. Check the shape as you work by fitting the strip into its recess.



After securing strips with epoxy, bore holes through plane and insert brass rivets. Mushroom rivet ends by hammering lightly.

Use a belt sander to trim the rivet heads and brass strips flush with the plane body. Work slowly to avoid overheating.

With mahogany blank glued to brass knob, enlarge screwhole with No. 25 drill bit. Then, tap the hole for 10-24 threads.



Install headless screw in knob and mount knob in lathe. Turn mahogany cap to finished shape and sand smooth.

Plane iron comes hollow-ground, but not honed. Before trying out the plane, use a water stone or oilstone to sharpen edge.

Adjustment

To adjust the plane iron, first rest the plane on a flat surface and loosen the brass screw, so the cutting edge aligns with the plane sole. Then tighten the screw so the cutter is held in position.

To move the plane iron out for a coarse cut, tap the front of the body with a hammer. To move the blade in, lightly tap the back of the plane. For lateral adjustment, gently tap the plane on either side. PM

HOME IMPROVEMENT

Installing New Phone Lines

These days, one phone line may not be enough. Here's how to expand your system.

BY NEAL BARRETT

● Telephones used to be just for talking. That was when every home had a single phone, no matter how many folks used it. Even an extension set was a luxury.

Nowadays, household phones are also used for transmitting documents, spreadsheets and images, and for accessing databases. More than ever, the telephone is your link to local and global information, services and products. In fact, along with a fax machine and computer, many folks have discovered that their place of employment is as handy as the nearest phone.

Whether you're setting up your own office or simply want to keep the family's Web surfing from interfering with important calls, you've probably found that your single-line service just can't handle the load. Thankfully, expanding your system is a lot simpler than you might imagine.

System basics

Most homes with one telephone number are already wired to handle two phone lines. The typical residential system consists of a service line to the house that contains two pairs of wires. Each pair can handle a single phone line. The wiring inside your home also consists of two pairs of conductors. So if you have only one phone in your home, only half of your system is being used. To install a second line, all that you need to do is get some household wiring and pay a fee to your phone company for activating the new number.

If you need more than one extra line, the phone company will probably install an additional 2-pair line so you can handle up to four numbers.

Telephone service lines enter the home and terminate at circuit-protector boxes that are usually located in the basement and attached to a floor joist. A circuit-protector box contains two insulated blocks, each with two terminals for the two phone lines. From the circuit box, the wires lead to jacks, which are the small, wall-mounted boxes that accept the plug-in phone connectors.

You'll find that the telephone wires are color-coded to match the connections in the box and jack. Red and green wires make up one telephone line and the black and yellow wires make up the other line.

In some cases, you'll find an alternative color-coding. In this case, a wire that's blue with white bands or solid blue corresponds to a red wire; a white wire with blue bands matches green; orange with white bands or solid orange should be paired with the yellow wire; and a white wire with orange bands corresponds to black.

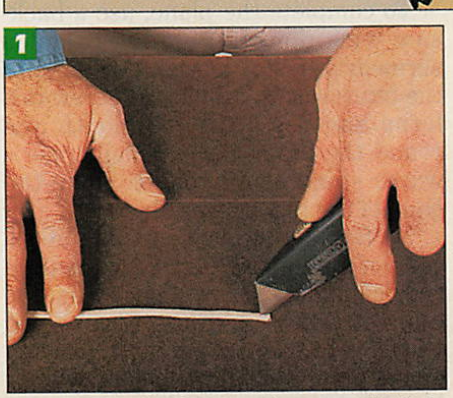
Providing that the inside wiring is connected properly at the circuit-protector box, you can use a 2-line phone at an existing jack as soon as the phone company activates the new number. However, if you need to install a jack at a new location, it's best to run new wire from the circuit-protector box. Phone wire comes in spools of various lengths and you can usually buy it cut to the length you need. Be sure to buy enough to do the job so you won't have to make any splices.

Running new wire

Before wiring the circuit box, make a small slit in the end of the wire's sheathing (Photo 1). Remove the box cover and push the wire through the rubber gasket at the end of the box (Photo 2). Using the slit as a starting point, peel back about 3 in. of sheathing and cut away the waste (Photo 3).

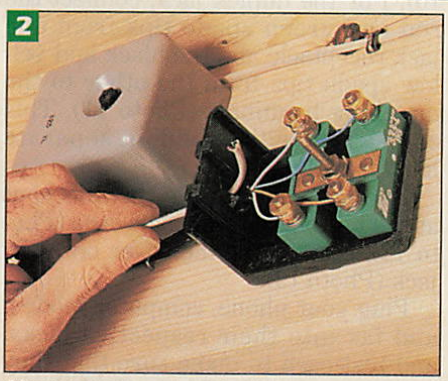
Measure the required length for each wire to neatly reach its terminal, cut the wires to length and strip ¾ in. from each end (Photo 4). Then, pull the cable back through the gasket—leaving only the necessary amount in the box. Secure the cable to the joist with staples designed for phone or stereo wire (Photo 5).

Attach each conductor to its terminal following the correct color-coding.

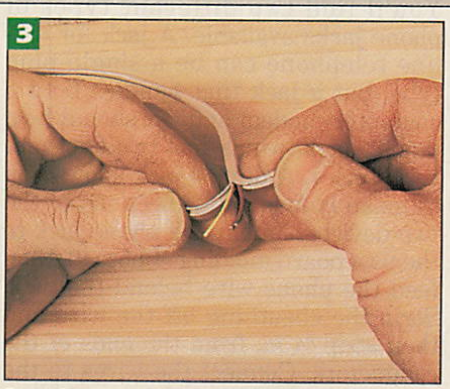


Use a utility knife to make a small slit in the end of the wire sheathing. This will make it easier to peel away insulation.

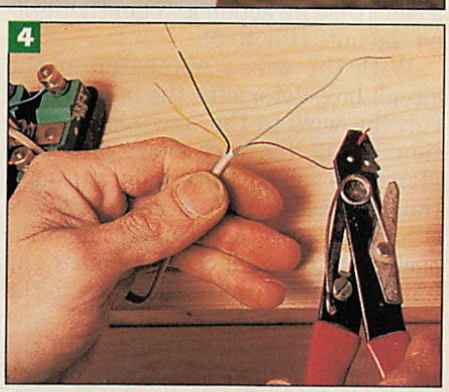
P.M. PHOTO BY JOHN GRIEBSCH



After removing the circuit-box cover, feed the new phone line through the rubber gasket at the end of the box.

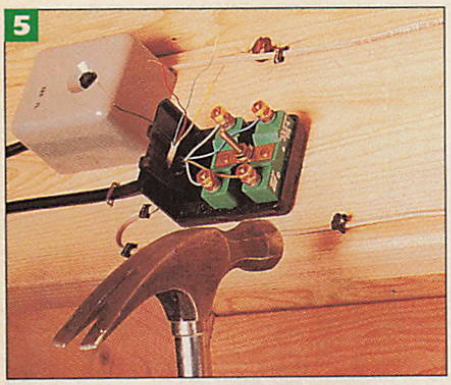


Starting at the slit, peel back the sheathing. Expose about 3 in. of wire and cut off the waste with a utility knife.

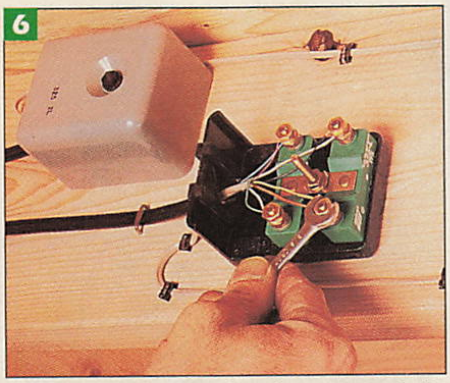


Pull wire back to determine the length of each lead to its terminal. Cut wire to length and strip ends ¾ in.

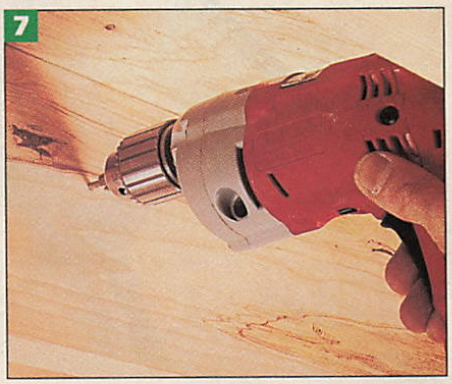
STEP-BY-STEP PHOTOS BY NEAL BARRETT



Staple the wire to the ceiling joist. Use staples designed for phone or stereo wire and secure the wire every 6 to 8 in.

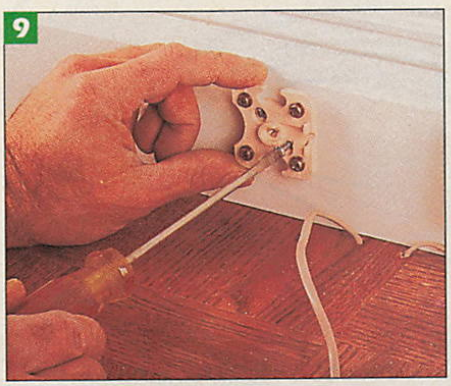


After looping each wire around its matching terminal, use a small wrench to gently tighten the terminal nuts.

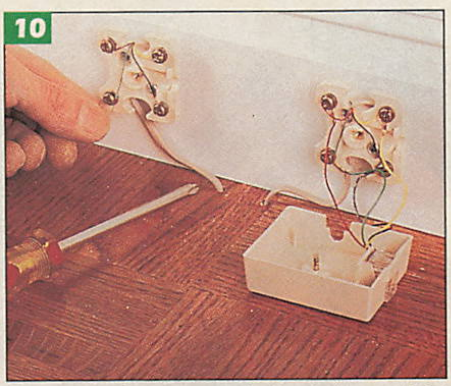


Where required, bore holes through joists to route phone wire. A 3/16-in.-dia. bit is suitable for single lines.

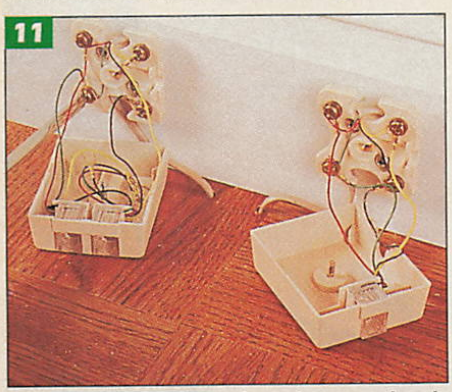
Near jack location, bore 3/16-in.-dia. holes from room above for each cable. Keep holes close to baseboard molding.



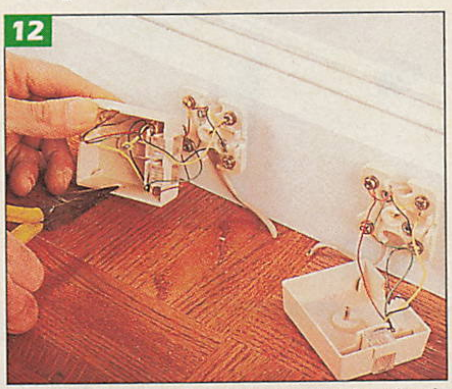
Mount the base of the phone jack to the baseboard using wood screws. Feed wire through back of jack and strip ends.



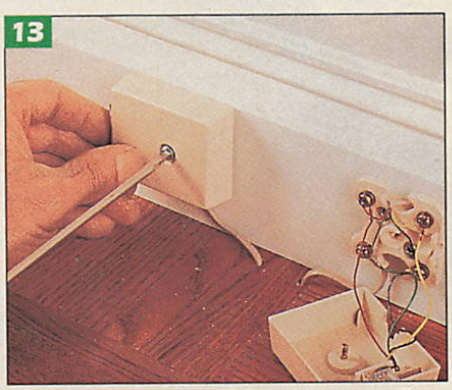
Connect wires to terminals. Jack on right handles 2-line phone. Duplex jack on left handles two separate plugs.



For duplex jack, red and green leads supply one device plug. Black and yellow leads go to second input.



Use pliers to remove knockout in plastic jack cover. This provides space for wire so cover fits against baseboard.



Install jack cover on base with screw. Then plug in phone and test. Check connections if line doesn't function.

Loop each wire around its terminal in a clockwise direction and gently tighten the nuts (Photo 6).

With the wires connected at the circuit box, determine the best path to run the wire to the new phone location. Staple the wire every 6 to 8 in. along the joists. Bore holes through the joists as required to route the wire (Photo 7). Bore a 3/16-in.-dia. hole for each wire through the floor near the intended jack location and next to the baseboard molding (Photo 8).

Feed the phone wire through the hole and into the room. Give yourself plenty of wire to work with and staple the wire to the joist as close as possible to the hole.

Installing the jacks

You'll find two different types of phone jacks available. A jack for a 2-line telephone can be a single-plug type, but a jack that handles both a computer modem and fax should be a duplex jack, which has two separate receptacles. A duplex jack allows you to make individual connections to the two devices. Mount the phone jack to the baseboard molding (Photo 9), then feed the phone wire behind the jack. Strip the sheathing off the wire and then strip 3/4 in. from the ends of the conductors. Connect the wires to the matching color-coded jack terminals.

For the 2-line phone jack, connect the matching-color spade tips on the jack cover to each terminal (Photo 10). For the duplex jack, connect the red and green spade tips from one jack receptacle and the black and yellow spade tips from the other to the matching terminals (Photo 11). This connection will provide a separate line for each jack.

Use pliers to remove the knockout at the bottom of each jack cover (Photo 12), then screw the cover onto the jack (Photo 13).

Plug your phone, computer modem and fax into their respective jacks, and test each to make sure that they function properly. If you find that a line is not working, check the terminal connections for loose wires. **PM**

STEP-BY-STEP PHOTOS BY NEAL BARRETT

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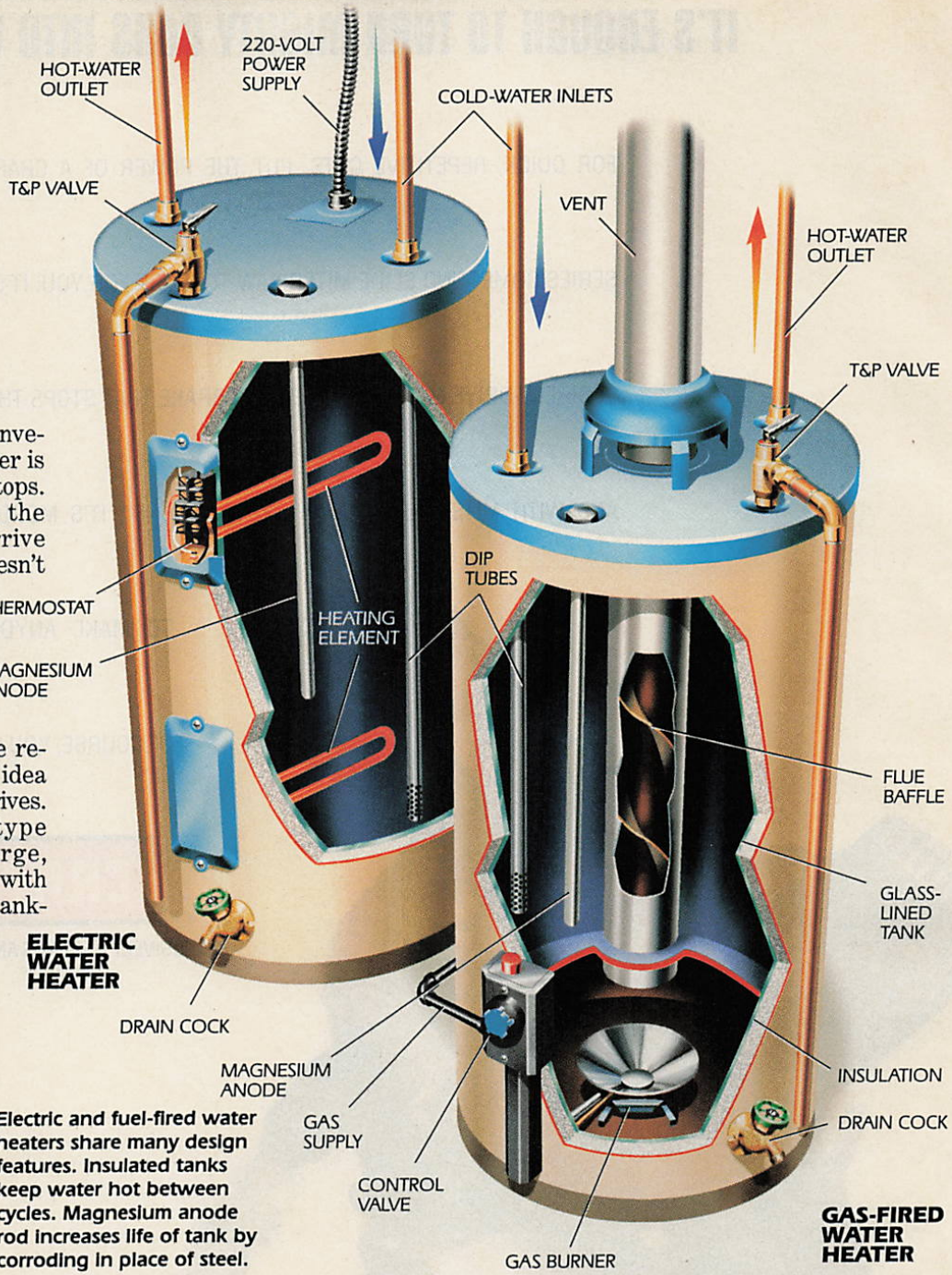
HOW IT WORKS

Water Heater

BY THOMAS KLENCK, Associate Home Improvement Editor
PM Illustrations by George Retseck

● Like many other household conveniences, a good supply of hot water is only truly appreciated when it stops. And if it stops when you're in the shower, this realization can arrive quite abruptly. Fortunately, it doesn't happen that often. The systems that provide hot water are generally reliable and operate for years without a hitch. But when the hitch comes, some background can help. Even if you can't make the repairs yourself, you'll have a good idea what to tell the doctor when he arrives.

Most homes have a tank-type water heater. If you find a large, cylindrical tank standing on end with pipes attached to it, you have a tank-type system. If you don't find a tank, but you have a hot-water heating system that heats your home, it's likely that the hot water reaching your taps is heated by the boiler. In other cases, hot water may be supplied by a stand-alone instantaneous water heater that's mounted near the fixture it serves.



Electric and fuel-fired water heaters share many design features. Insulated tanks keep water hot between cycles. Magnesium anode rod increases life of tank by corroding in place of steel.

Tank-type water heaters

The standard water heater comes in two flavors: electric and fuel-fired. In the latter, the fuel most commonly used is gas, either natural or propane, but oil-fired heaters are popular in many areas. Fuel-fired units have a vent pipe at the top to carry away exhaust gases. Electric models, on the other hand, simply have a power cable that connects the heater to your electric service panel.

The job of the tank-type heater is not only to heat the water, but to store it until it's ready to use. Therefore, in addition to the tank's heating system, every tank is equipped with insulation to help keep the water warm between heating cycles.

On top of every tank you'll find the water supply and delivery pipes. The supply pipe routes cold water to the bottom of the tank through the dip tube. The hot-water delivery pipe takes water from the top. For safety, all water heaters are equipped with a T&P valve (temperature-and-pressure relief valve). This valve opens if either the temperature or pressure of the water exceeds a safe limit. The valve is connected to a pipe that runs down the outside of the tank, ending about 6 in. from the floor. It's a good idea to keep a bucket under the end of the pipe to catch water if the valve opens. The T&P valve should not be connected to a drain. If the valve did open, a sign that a problem exists, you might never know that it had opened.

Most tanks are made of steel, which is glass-lined on the inside to help prevent corrosion. In fact, corrosion is the primary reason that tanks fail. Once rust produces a hole, there are temporary fixes, but the tank should be replaced. All tanks also have an anode rod to control corrosion. The magnesium anode rod protects the tank by corroding in place of the steel. Because the rod is designed to corrode, it will eventually wear away. After this happens, corrosion of the steel accelerates. It's a good idea to check the anode rod once a year, and replace it if necessary (see Homeowners Clinic, page 92, Aug. '97). At the bottom of every tank is a drain cock to empty the heater, and a valve on the supply pipe allows you to shut down the hot-water plumbing without affecting the cold-water supply to the house.

(Please turn to page 92)

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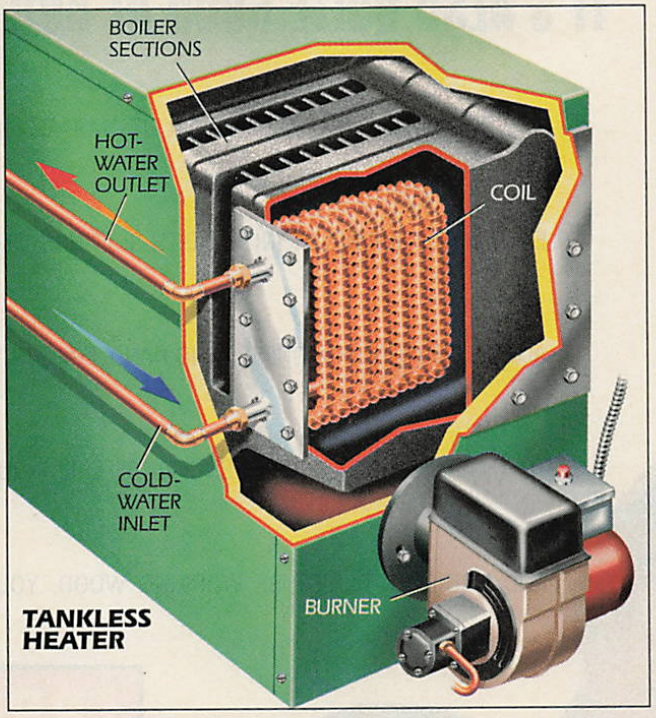
Electric water heaters

The typical electric unit is wired to a 220-volt circuit. To heat the water, the current passes through electrical-resistance heating elements—usually two, one at the middle of the tank and one at the bottom.

Power is delivered to each element through a thermostat—a switch that senses the water temperature. When the temperature drops, the switch closes to allow current flow, and it opens when the temperature reaches its preset limit. Thermostats have a dial for setting the maximum water temperature—generally between 130° and 140°F, or as low as about 120° F for increased energy savings and scald protection.

When a hot-water tap is opened, cold water enters the tank through the dip tube and the drop in temperature triggers the thermostat and element at the bottom. As the water at the top of the tank is replaced by cool water, the temperature at the top thermostat drops and its element kicks in. When the tap is turned off, the heating elements continue to carry current until the thermostats are satisfied.



A coil mounted in a hot-water heating system boiler supplies hot water to taps and appliances. This system relies on boiler operation and is most economical in winter.

Fuel-fired water heaters

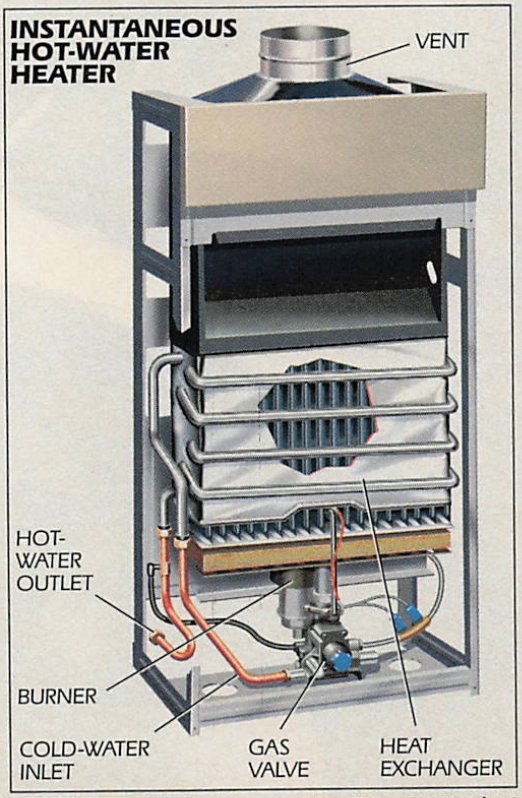
Instead of electrical-resistance elements, gas-fired heaters have a burner that's fed gas through a control valve and a thermostat switch. In an oil-fired heater, the burner is similar to that found on an oil-fired furnace. In either case, the burner is usually situated to throw a flame under the tank. The exhaust gases are vented either through a hollow core at the center of the tank or around the tank sides. Because fuel-fired heaters heat the tank, which in turn heats the water, there will be more wear and tear on the tank than with electric heat. A fuel-fired heater, therefore, may have a shorter life expectancy than an electric heater.

Heater effectiveness

Because water heaters both heat and store water, the rate at which the water is heated and the capacity of the tank affect the supply of hot water at your fixtures.

The speed at which a unit heats water is called its recovery rate. This figure indicates the amount of water in gallons that can be heated to 100° F in 1 hour. Once you draw water faster than it's heated, the temperature drops.

However, because the tank stores hot water, its capacity also affects the ongoing availability at the tap. Choosing a water heater that has an appropriate capacity and recovery rate depends on how much water your home demands and how your unit heats the water. Typically, heaters with low recovery rates have a high tank capacity. Although it takes longer to heat the water, there's more of it for intermittent use. Electric heaters fall into this category. On the other hand, a fuel-fired heater with a high recovery rate needn't have a large tank, because it can heat the water faster. In general, electric models have the lowest recovery rate, and oil-fired units have the highest.



Stand-alone instantaneous heaters create hot water only when it's called for. These smaller units are mounted near the fixture they serve.

Tankless heaters

If your home doesn't have a hot-water tank, you probably have a hot-water or steam home-heating system that also heats water for your taps. To accomplish the job, your boiler has a tankless water heater. In this system, a coil of pipe is connected at one end to the cold water supply, and at the other to your hot-water delivery piping. As the boiler heats the water that warms your home, that water heats the coil, creating hot water at your taps.

Because tankless heaters only heat water as it's used, there's no cost for maintaining heat in a large volume of water during periods of low usage. However, they do have a few drawbacks. First, the hot water generated is far hotter than necessary, so a cold-water mixing valve should be installed to reduce the chance of scalding. Second, the boiler must fire to generate hot water—which is efficient during the winter months, but decidedly more wasteful when the weather is warm. Like tank-type heaters, tankless heaters are designed to achieve a specific heating rate. Once the rate is exceeded by demand, the temperature of the water drops. In some cases, storage tanks are connected to the heating coil to increase hot-water availability.

In addition to boiler-mounted tankless heaters, stand-alone units are available. Gas-fired instantaneous water heaters utilize a coil and heat exchanger to heat water as it's required. Like boiler-mounted units, instantaneous water heaters don't use energy to maintain the heat in a volume of water, but only fire as hot water is required. A downside is that stand-alone units typically have a lower flow rate than boiler-mounted systems and may fall short during periods of high demand. PM

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Homeowners Clinic

BY NORMAN BECKER, P.E.,
Contributing Editor
PM Illustrations by
George Retseck

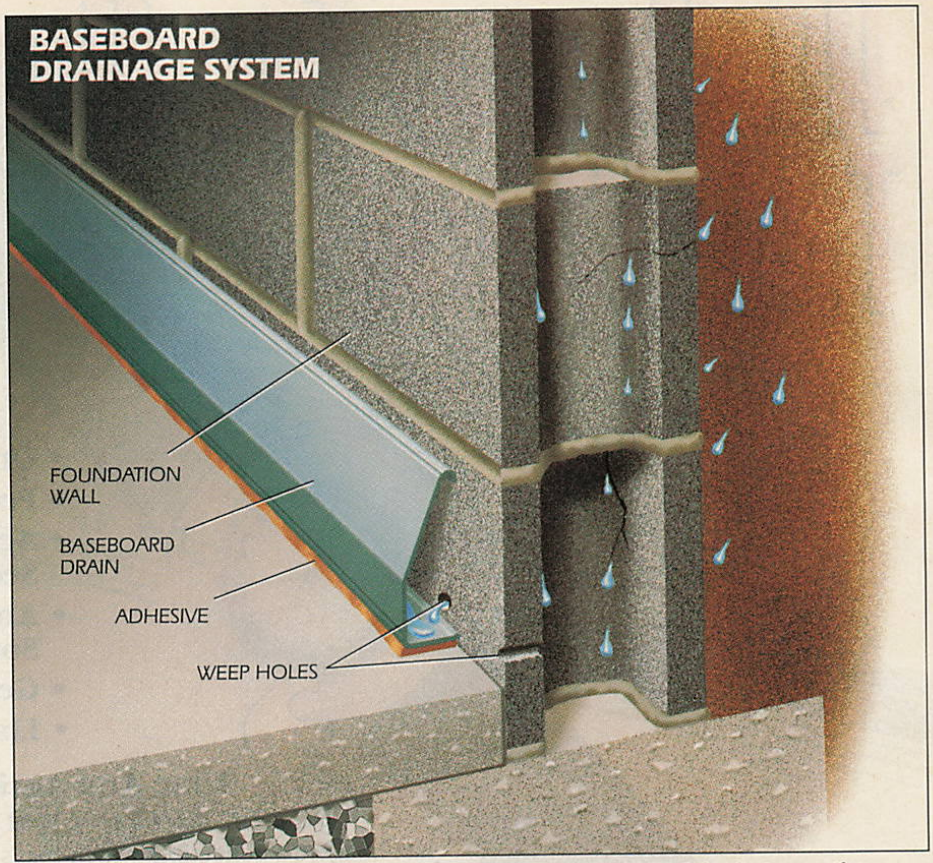
Baseboard Drainage System

Water leaks between the foundation wall and my basement floor. I have heard of plastic baseboards that divert this water to a sump pump. Where can I get more information on these products? ROBERT YOUNG
MIDDLEBURY, VT

The joint between the foundation wall and the floor is a common entry point for water. Ideally, the way to correct this is to intercept or divert subsurface water before it reaches the foundation. However, if this is not practical, plastic baseboards can control the seepage.

One baseboard drainage product is the Squidgee Dry System manufactured by Beaver Industries, 1950 8th Ave., Baldwin, WI 54002; 800-828-2947. It can be used with either poured concrete or concrete-block foundation walls. It consists of preformed hollow plastic baseboard sections, splices, inside and outside corners and endcaps. The system is secured to the concrete floor slab, adjacent to the wall joint, with an adhesive sealant that cures even under wet conditions.

The average cost per foot for the system is $4. It's sold through hardware stores, home centers and the manufacturer.



A baseboard drainage system traps water that leaks through the joint between the foundation wall and the floor. It diverts the water to a sump pump.

Aluminum Versus Vinyl Siding

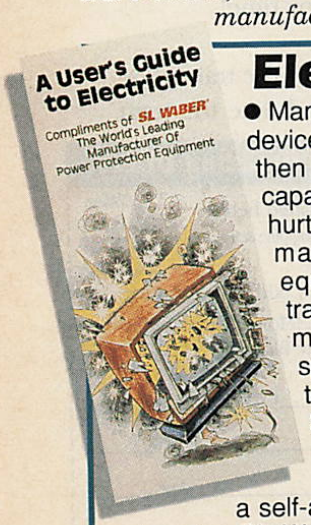
We want to install new siding on our home. We are wondering which siding would you recommend, vinyl or aluminum? GERMAINE BURNS
MACOMB, MI

I don't have a preference. No siding material is perfect, and your choice should be based on which siding, in your opinion, has more advantages than disadvantages.

Aluminum siding comes smooth, or embossed with wood grain. It is relatively maintenance-free, corrosionproof and termiteproof, and it won't rot. Its surface finish is a durable, baked enamel paint.

If aluminum siding is scratched, the silver color of the bare aluminum below is exposed. However, the scratch can easily be repaired with touchup paint. One problem with aluminum siding is that it can be dented, say, by a baseball striking it or a ladder pressing on it.

Vinyl siding is very much like aluminum siding in size, shape, application and ap-



Electrical Protection

● Many people invest in high-tech electronic devices for their home and home office and then buy a surge suppressor of unknown capacity. If this describes you, it couldn't hurt to read this brochure by SL Waber, a manufacturer of power-conditioning equipment. It explains power surges, transient spikes, undervoltages, electromagnetic interference, clamping response time, different types of line protection and Underwriters Laboratories Standard UL 1449. You may read it and find that your electronics are well protected, or just the opposite. Send a self-addressed, stamped business-size envelope to: SL Waber, Dept. PM, 520 Fellowship Rd., Suite 306C, Mt. Laurel, NJ 08054. *—Roy Berendsohn*

Electrical Help

● For $2, this slide chart is tough to beat for information on electrical cable. Flip it open and align the sliding arrow with the application. For example, when you align the arrow with "attic fan," "12-ga., 2-conductor cable with ground wire" registers in the window above it. Then, use the slide chart on the back and tables inside for detailed information on one-way cable distances, wire gauge, wattage, voltage drop and wire type. It's better to sort this out in the peace and quiet of your home than in the din of a home center or hardware store. Send a check and self-addressed, stamped envelope to General Cable, Att: Romex Brand Selector, 4 Tesseneer Dr., Highland Heights, KY 41076. *—R.B.*

PM PHOTOS BY ROSARIO CAPOTOSTO

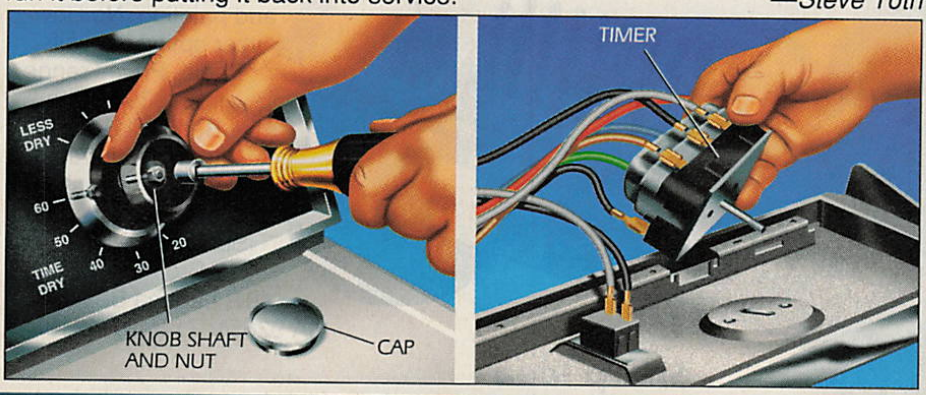
Replacing A Dryer's Dial Timer

APPLIANCE CARE TIP

● If the timer dial on your dryer no longer advances through its cycle, and the only way you can shut the dryer off is to manually advance the dial, it's time to replace the faulty timer. The motor windings inside the timer may have opened, or a gear inside it may be worn or broken. In either case, the timer won't move. A replacement costs about $60. If a new timer is unavailable for your machine, you may be able to send the old one out to be rebuilt (see Appliance Care Tip, page 93, Aug. '97).

To install the new timer, first unplug the dryer. Next, remove the knob. We show a Maytag type, in which you simply pry off the cap in the center of the knob and remove the nut holding the knob to the shaft. Other knobs are held on with a screw. Once the knob is pulled off the shaft, you'll find two screws holding the timer to the control panel. Remove the screws, tip the control panel forward, and place it on an old towel laid across the top of the appliance. Lift the timer away from the control panel.

Use masking tape to label the wires on the malfunctioning timer, and draw a diagram that shows which wire goes to which contact. Remove the wires from the timer and install the new one. Another option is to place the new timer next to the old one and simply transfer the wires. Reassemble the machine and test run it before putting it back into service. —*Steve Toth*



pearance. Vinyl siding normally does not dent from impact. However, during very cold weather, the siding becomes brittle, and a hard blow could crack or shatter it. Vinyl siding expands and contracts as the temperature changes. If it is improperly nailed, this movement can result in waviness in the vinyl panels.

Dehumidifying A Damp Basement

We have a moldy, musty odor in our basement that seems more pungent in the spring and fall. We have tried using mesh sacks filled with calcium chloride to reduce the odor, but they're ineffective. Occasionally, the sacks drip water. How can we decrease the odor?

DAVE KOENEGSTEIN
WALNUT HILL, IL

The sacks hanging in your basement absorb moisture that can lead to mold and mildew growth, but they are not as effective as a mechanical dehumidifier. You need an electric dehumidifier. These appliances have a humidity control and will run continuously until the humidity setting is reached. The water that they condense out of the air, known as condensate, collects in a tank. You have to manually empty the tank, pump the condensate to a disposal drain, or drain it with a hose to a floor drain.

Moisture problems such as yours are more apparent at times of high humidity. During warm weather, the basement is cooler than the outdoors. Warm air can hold more water vapor than cool air. When warm outside air works its way into the basement, its temperature drops and causes the relative humidity in the basement to increase. Aside from contributing to mold and mildew growth, this makes the basement air feel clammy and uncomfortable during the summer. PM

DO YOU HAVE A HOME-MAINTENANCE OR REPAIR PROBLEM?

Just ask Norman about it. Send your question to Homeowners Clinic, Popular Mechanics, 224 W. 57th St., New York, NY 10019. While letters cannot be answered individually, problems of general interest will be discussed in the column.

A History of Consumer Protection and Good Housekeeping's Promise To America

1909

Tested and Approved by the Good Housekeeping Institute Conducted by Good Housekeeping Magazine

For the first time, consumers look to the Good Housekeeping Seal for quality assurance.

1941

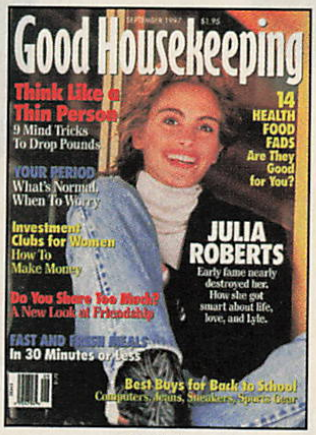
Replacement or Refund of Money — Guaranteed by Good Housekeeping — If Not As Advertised Therein

The "Guaranty Seal" replaces the "Seal of Approval."

1975

A Limited Warranty to Consumers — Good Housekeeping Promises — Replacement or Refund If Defective

The Seal now states all guarantee conditions with the phrase: "A Limited Warranty to Consumers Good Housekeeping Promises Replacement or Refund If Defective."


Good Housekeeping
Think Like a Thin Person
9 Mind Tricks To Drop Pounds
YOUR PERIOD
What's Normal, When To Worry
Investment Clubs for Women
How To Make Money
Do You Share Too Much? A New Look at Friendship
FAST AND FRESH MEALS
In 30 Minutes or Less
14 HEALTH FOOD FADS Are They Good for You?
JULIA ROBERTS
Early fame nearly destroyed her. How she got smart about life, love, and Lyle.
Best Buys for Back to School
Computers, Jeans, Sneakers, Sports Gear

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1997

Limited Warranty to Consumers — Good Housekeeping Promises — Replacement or Refund If Defective

A new look for the new millennium.

The Good Housekeeping Seal is a highly-recognized statement of our renowned Consumers' Policy published in every issue of the magazine: if any product bearing the Good Housekeeping Seal proves to be defective at any time within two years of purchase, Good Housekeeping will replace the product or refund the price paid for it.

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The Promise of
Good Housekeeping
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Great Stuff

From home improvement to outdoors, automotive to electronics, here's the newest gear you'll want to own.

SEPTEMBER

Street Fighter

Sure, your Jeep Wrangler is tough. But now you can make it look even tougher—like something out of a SWAT team arsenal—with an Urban Survival Options Modular Appearance Package. Three packages offer varying degrees of intimidation, as well as increasing interior volume. Packages offer modification panels for doors, bed rails, hood, cowl, rockers and flares. All of the parts are bolt-on and made of fiberglass, and they require some finishing and painting. No Howitzer option is available. Prices range from $395 for the Bed Rail Package to $1095 for the Hood/Flare Package. Contact Urban Survival Options, 219 Broadway, No. 401, Laguna Beach, CA 92651; 714/497-4213.

Sharp Idea

Darex is well-known for its industrial sharpening equipment. We tried the company's Drill Doctor, a drill-bit sharpener for the home shop, on a batch of high-speed steel bits and found it to be a remarkably fast and effective device. Furthermore, it does something that no other machine in its price range can do—produce a split point on a bit's tip. You can sharpen any drill-bit material with it, from high-speed steel to carbide. To use it, you place the bit in a chuck, insert the chuck into a sharpening port, grind the tip, then insert the chuck into a pivoting point-splitting port. The whole process takes just a few minutes and produces a nicely machined tip with the correct shape and offset. It can't sharpen bullet point bits or other bits that don't have a cone-shaped tip, but it can sharpen masonry bits. There are two models: the 500SP, which sharpens bits 3/32 to 1/2 in. in diameter, and the 750SP, which handles bits 3/32 to 3/4 in. in diameter. The former costs about $130, and the latter about $170. Both are sold at hardware stores and home centers. Contact Darex Corp., Box 277, Ashland, OR 97520; 888-693-7455.

Heartbeats Of America

Would you know what to do if someone was choking or needed CPR? The CPR Prompt Rescue and Practice Aid incorporates sophisticated microprocessor and voice-chip technologies that can walk you through any of 12 different CPR and choking emergencies. You should have prior training in CPR (a home learning system is available). The battery-powered unit sells for $99.95 from County Line Ltd., Health and Safety Products Div., 4543 Taylor Ln., Warrensville Heights, OH 44128; 800-667-3541.

Better To Sea With

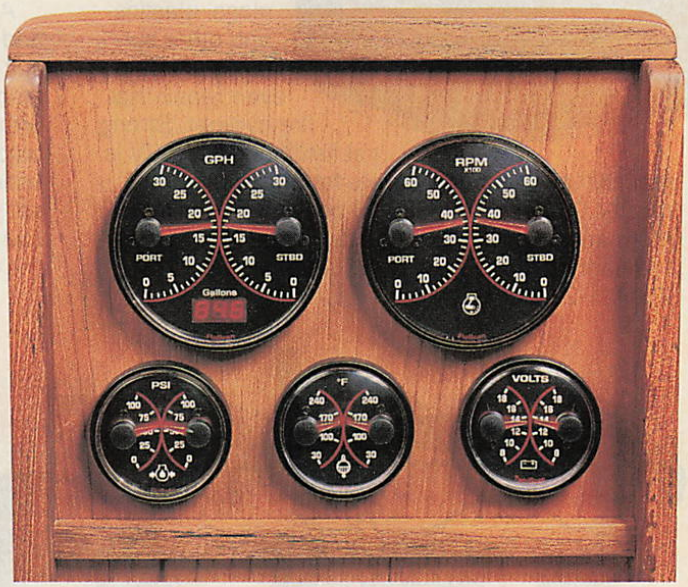
Equipped with a state-of-the-art microprocessor, Stiener's new 7 × 50 Commander Electronic II binoculars safely and accurately bring high-tech optics to the high seas.

The electronic compass processes faster and is more reliable than older models. It gives you almost instantaneous digital bearings that are precise to half a degree. The new circuitry also makes it easier to store and change declination, which is the horizontal angle between true and magnetic north that changes depending upon location.

Waterproof and shockproof to U.S. Navy standards, the binoculars remain accurate up to a 10° incline, which provides an advantage in nasty seas. Other functions include a 9-bearing memory, continuous bearings, auto power off and a bearing button that provides average bearings. The glasses, which weigh 40 ounces and offer a 385-ft. field of view at 1000 yd., sell for $1400 at marine, camera and optics stores. Contact Pioneer Research, 216 Haddon Ave., Westmont, NJ 08108; 609/854-7742; fax: 609/858-8695.

Prevents Sunburn

Thompson's Wood Finish Colors are formulated so that you can spend more time enjoying your deck and less time staining it. The colors are solvent-based, light-bodied pigmented stains that can be applied with a pump sprayer. After you're done, you just clean the sprayer with soap and water. When the stain dries, the wood grain remains visible. The company says the pigment lends extra protection against ultraviolet light. A gallon costs $20 to $25 and covers about 200 to 250 sq. ft. of outdoor lumber. The stains are sold at hardware stores and home centers. Contact Thompson's, 825 Crossover Ln., Memphis, TN 38117.



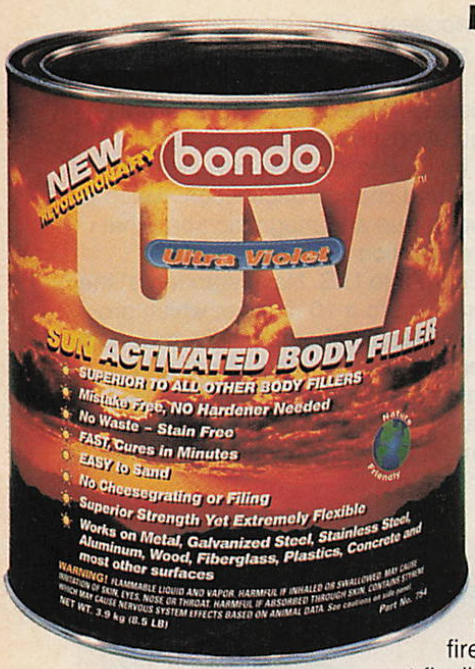
Double Gauge

Most twin-engine boats lose a lot of panel space to gauges, but TwinScan Engine Instruments are about to change that. These new gauges borrow a trick from the aviation industry by combining like parameters for both engines in one meter.

Vital engine information regarding gallons per hour, rpm, oil pressure, temperature and battery voltage only require five gauges instead of 10. And since the pointers oppose each other, these gauges make it especially easy for the skipper to spot a deviation between the engines. A microprocessor that matches preset performance curves and miniaturized meter systems are what make it all possible. Smaller engine monitors cost $250, while the larger tachometers list at $495. They're available at retail marine stores or directly from the manufacturer, FloScan, at 3016 N.E. Blakely St., Seattle, WA 98105; 800-522-3610; fax: 206/532-4961.

Steady As She Goes

Edelbrock's new Inertia Active System (IAS) shocks provide mechanical variable damping based on a unique valve combination. The system instantly switches between a soft and a firm ride for optimal handling and comfort. We tried them on our '93 Jeep Grand Cherokee, and the ride and handling were vastly improved. The IAS Performer Shocks are available for trucks, SUVs, Camaros, Firebirds and Mustangs, and cost $92.95. Contact Edelbrock Corp., 2700 California St., Torrance, CA 90503; 310/782-2900.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bondo
UV
Ultra Violet
SUN ACTIVATED BODY FILLER
SUPERIOR TO ALL OTHER BODY FILLERS
Mistake Free, NO Hardener Needed
No Waste – Stain Free
FAST, Cures in Minutes
EASY to Sand
No Cheesegrating or Filing
Superior Strength Yet Extremely Flexible
Works on Metal, Galvanized Steel, Stainless Steel, Aluminum, Wood, Fiberglass, Plastics, Concrete and most other surfaces

Filler Up

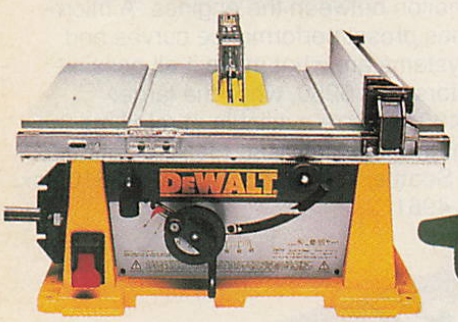
Didn't see that fire hydrant when you backed up, eh? Too bad. Bondo UV is a new, sun-activated body filler that is ready to use and requires no hardener. The filler cures in minutes and works on metal, galvanized steel, stainless steel, aluminum, fiberglass, plastics and other surfaces. It could even repair that fire hydrant. Strong, yet flexible, Bondo UV is available at auto parts outlets for prices ranging from $4.99 per pint to $29.99 per gallon. For more information, contact Bondo/Mar-Hyde Corp., 3700 Atlanta Industrial Pkwy. N.W., Atlanta, GA 30331; 800-421-2663.

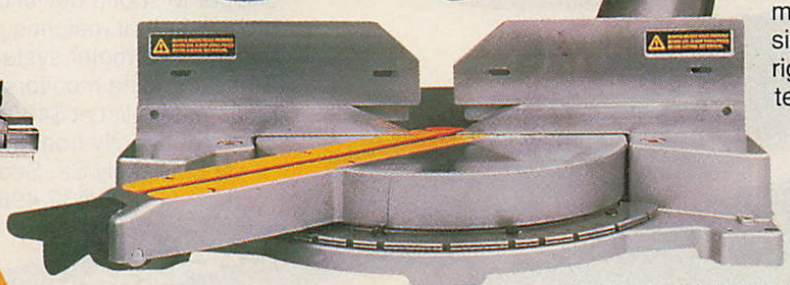
Like A Martini

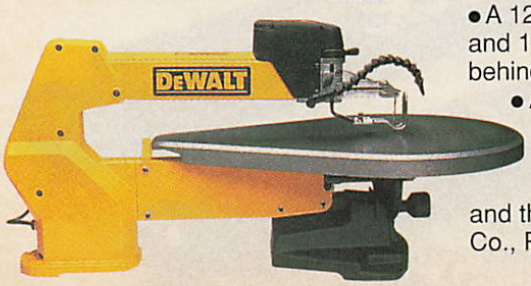
Kokatat's new front-entry drysuit makes staying dry easier than ever. The Swift Entry features a full-length diagonal zipper across the front, making it simple to get in and out of the suit.

The new and lightweight metal zipper, which is more waterproof and more durable than standard nylon-coil zippers, makes front entry possible. In conjunction with the gaskets that close off ankle, wrist and neck openings, the zip-front suit keeps you dry in even the worst conditions.

Available in both men's and women's sizes, the suit also injects a sense of fashion into the drysuit world with contrasting double patches on the seat and knees. The Swift Entry will set you back $304, and you can call 800-225-9749 to find the dealer nearest you.







Line Up

If portability and compactness in workshop machinery are important criteria for you, then consider DeWalt's four benchtop woodworking machines. Here are a few highlights from the new product line:

- A 10-in., 13-amp table saw with 24½-in. ripping capacity and a fence adjusted with a rack-and-pinion mechanism on both sides of the table. Its aluminum table has a friction-reducing coating. It costs $525 to $550.
- A 12½-in., 15-amp thickness planer with a lever-lockdown mechanism designed to add rigidity to the cutterhead in order to eliminate snipe at the end of a board. Also, a magnifying lens on the depth scale makes it easy to read. It costs $425 to $450.
- A 12-in. dual-compound sliding miter saw that will crosscut stock up to 5¼ in. thick and 12 in. wide at 90°. For maximum visibility at the cutline, the saw motor is set behind the blade. Power is transmitted to the arbor by a belt. It costs $650 to $700.
- A 20-in. parallel-arm scroll saw that has electronic speed control, toolfree blade-changing and a large cast-iron table that tilts to 45° in both directions. It costs $430 to $470.

All these machines are sold at woodworking tool stores, home centers and through tool catalogs. For more information, contact DeWalt Industrial Tool Co., P.O. Box 158, 626 Hanover Pike, Hampstead, MD 21074; 800-433-9258.

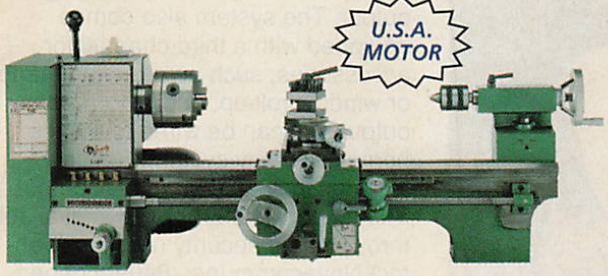
(More New Products on page 100)

ONLY THE BEST *from* GRIZZLY!

For over 14 years, Grizzly has been serving serious hobbyists and small machine shops with their metalworking needs. We import high quality machines and sell direct to the user at excellent prices. We have 2 large warehouses full of equipment ready to ship the same day and back up our merchandise with large parts and service departments. Try us! Call today for your **Metalworking catalog.**

9" x 19" BENCH LATHE

U.S.A. MOTOR



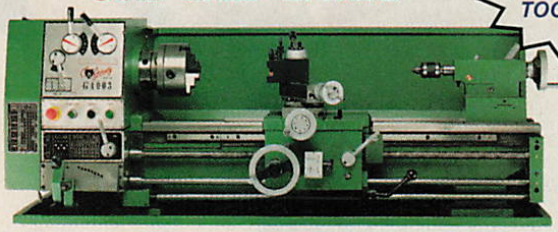
- Swing over bed 9"
- Distance between centers 19"
- Swing over cross slide 5"
- Hole through spindle ¾"
- Motor ¾ H.P., 110V
- Approx. ship. weight 300 lbs.

G4000

$845.00

12" x 36" GEAR HEAD GAP BED LATHE

WITH QUICK-CHANGE TOOL POST!

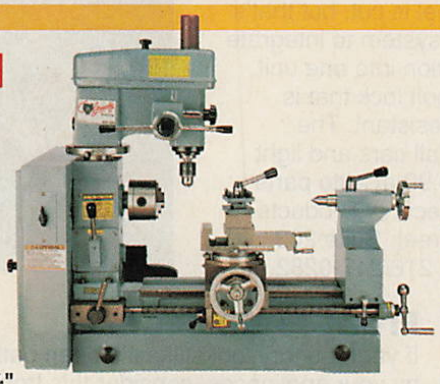


- Swing over bed 12"
- Swing over gap 17"
- Swing over cross slide 7"
- Distance between centers 36"
- Motor 1½ H.P., 220V
- Approx. ship. weight 1100 lbs.

G4003

$1995.00

COMBINATION 16½" x 17" LATHE/MILL



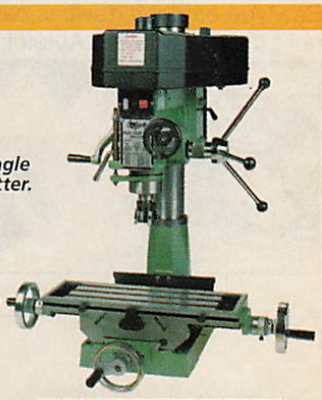
- Swing 16½"
- Distance between centers 17"
- Length 41"
- Width 23"
- Bed width 5½"
- Hole through spindle ¾"
- Spindle taper #3 M.T.
- Motor ¾ H.P., TEFC, single phase, 60 Hz, 110V, 8 amp, 1650 R.P.M.
- Approx. ship. weight 357 lbs.

G4015

$895.00

MILL/DRILL

The Model G1005 Mill/Drill comes complete with ½" drill chuck, small angle drilling vise, and carbide-tipped fly cutter.



- Spindle taper R-8"
- Spindle travel 3¾"
- Distance spindle to column 8"
- Max. dist. spindle to taper 14¾"
- Column size 3¾"
- Table size 6¼" x 20¼"
- Table travel 6" x 12½"
- Motor 1 H.P. single phase
- Drilling capacity 1"
- No. of speeds 12
- Range of speeds 110-2580 R.P.M.
- Approx. ship. weight 400 lbs.

G1005

$975.00

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U.S.A. MOTOR

This ½ horsepower benchtop drill press offers all the power and durability you'd expect from a full-sized machine.

- Motor ½ H.P., 110V
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- No. of speeds 12
- Drill chuck ⅝"
- Spindle MT #2
- Swing 14"
- Drilling capacity ¾" steel
- Table diameter 12¾" cast iron
- Table swing 360°
- Approx. ship. weight 155 lbs.

G4008

$189.95

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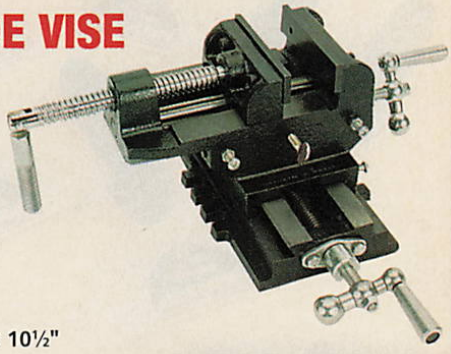
This vise features an exclusive slide bar under the vise jaw to prevent jaws from tilting up or sideways when tightening.



- Large 4" capacity
- Overall height 5¼"
- Base measures 5" x 10½"
- Jaw width 4"
- Jaw opening 3½"
- Bottom slide travel 4"
- Top slide travel 4"
- Approx. weight 25 lbs.

G1064

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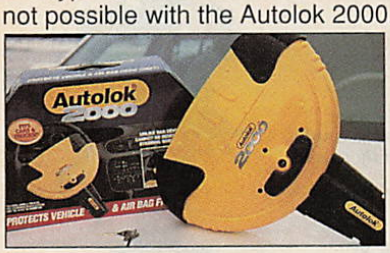
In The Bag

Bar-type antitheft devices can be removed if the steering wheel is cut, but that's not possible with the Autolok 2000. It is also the first security system to integrate vehicle and airbag protection into one unit. The system uses a deadbolt lock that is especially pick- and drill-resistant. The Autolok 2000 fits virtually all cars and light trucks, and it sells for $99.99 at auto parts stores. Contact Autolok Security Products Inc., 45 E. Washington Street, Suite 203, Chagrin Falls, OH 44022; 216/247-0282.



Long Ranger

With just about everything shrinking in size these days, it's no surprise that keyless-entry-system hardware has been reduced to a size smaller than a pager. The model KE200 has a range of 150 ft. and can be configured not only for regular passive and active door unlocking, but for trunk release, illuminated entry, and flashing light output. The system also comes equipped with a third channel for accessories, such as a remote starter or window roll-up, and a horn honk output that can be wired to a car's horn or security system. Security features include a starter kill output. The unit costs $99.95 and is available through auto security retailers. Contact Novacomm Inc., 6409 Independence Ave., Woodland Hills, CA, 91367; 800-757-3006.

Why Not?

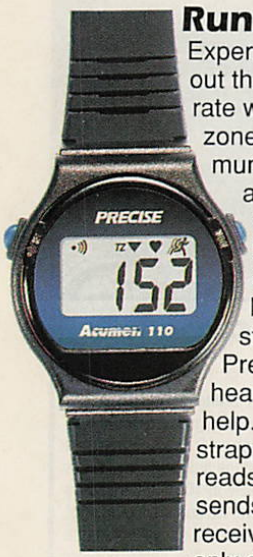
If other tools can be improved, why not the humble putty knife? Red Devil undertook the task of making putty knives, scrapers and taping knives more comfortable. The tools have stainless-steel blades with a full-length tang embedded in the handle, which makes them durable. The handles are made of a soft rubberlike material with a nonslip surface that feels great in your hand. A 1½-in.-wide, rigid-blade putty knife costs about $6, while a 6-in.-wide taping knife costs $12. The tools are sold at hardware stores and home centers. Contact Red Devil, 2400 Vauxhall Rd., P.O. Box 3133, Union, NJ 07083; 800-423-3845.

Front-End Loaders

If your laundry looks like it's been battered into submission by your appliances, consider this front-loading duo when you go appliance shopping. Maytag says that they are more gentle, more efficient and more energy-conserving than traditional top-loading machines. Compared to typical laundry appliances, the washer cuts water use by 40%, energy use by 65% and reduces drying time by 30%. Maytag says the washer's superfast spin cycle wrings as much water as possible from the laundry, and this contributes to drying efficiency. Also, unlike previous types of front-loading washers that had water sloshing through the door seal, this washer's water level doesn't even reach the bottom of the door. Instead, the machine's stainless-steel drum tips at a 15° angle toward the back. Laundry tumbles through the water in a left-to-right, right-to-left motion. The dryer uses a diagonal airflow that is supposed to increase drying efficiency so it can dry a load of clothes in about the same time the washer takes to wash them. The washer costs about $1000, and the dryer about $500. Both are sold at Maytag appliance dealers. Contact the company at 403 W. Fourth St. N., Newton, IA 50208; 888-462-9824.

Thick-Skinned

Before you tear out that old plaster or skin it over with drywall, you might consider this self-adhesive fiberglass mesh. You stick it on the wall or ceiling with overlapping seams, then double cut as you would wallpaper. Apply a skim coat of drywall compound or plaster over the mesh, and you've got a smooth and flat surface. It comes in rolls of 225 or 450 sq. ft. and both rolls are 36 in. wide. They cost about $44 and $85, respectively, at home centers, paint stores and drywall supply stores. Contact Perma Glas-Mesh Inc., 2201 Progress St., P.O. Box 220, Dover, OH 44622; 800-762-6694.



Running Rate

Experts recommend a workout that keeps your heart rate within a certain target zone (55 to 65% of maximum), which burns fat and builds stamina. If you overexert, your body switches into anaerobic mode, burning less fat and straining muscles. Precise's line of Acumen heart-rate monitors can help. A small transmitter strapped to your chest reads your heart rate and sends the information to a receiver. The receiver not only displays your heart rate, but it calculates your target rate and triggers an audible alarm if you stray out of the optimal training zone.

The receivers come in five models—three sports watches and two electronic-display units. Each offers a variety of features to fit personal needs, and prices range from $99 to $209. All the watches are water-resistant to 30 meters. Contact Precise International, 15 Corporate Dr., Orangeburg, NY 10962; 800-447-5300.

(More New Products on page 102)

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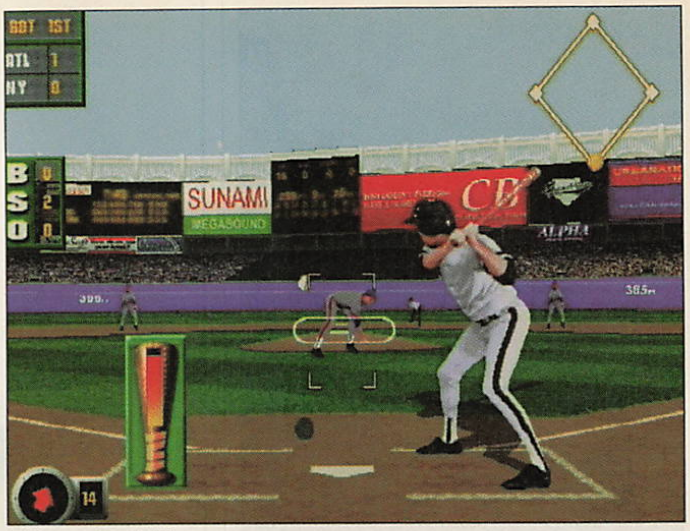

Play Ball!

Stock up on peanuts and Cracker Jacks, 'cause you'll be spending hours with Grand Slam, a baseball simulation featuring 3D renderings of authentic baseball stadiums and likenesses of more than 800 Major League players based on '96 stats and rosters—including August Minor League call-ups. The game uses artificial intelligence to capture the players' physical and mental games. What really sets this game apart is the addition of both a pitching and a batting meter. They allow you to control the windup, time the release and control the location and velocity of each throw, and time your swing and make adjustments at the plate. The game retails for $52.95 and is available for Windows '95 PC, Sony PlayStation and Sega Saturn. It's sold at retail electronics chains and through Virgin Interactive Entertainment, 18061 Fitch Ave., Irvine, CA 92614; 888-843-2661.

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Beam Me Up

Catz's MSC driving light looks good, fits most bumper openings and grilles, and comes with a 55-watt Xenon-charged bulb and a clear or gold iridium Borosilicate lens. A pair of the 3.54-in. lights comes with rotating mounting brackets and hardware and costs about $209. You'll find these Catz at specialty auto parts stores, not pet shops. Contact FET Inc., 16401 Gothard St., Huntington Beach, CA 92647; 800-433-8872.

Can't Lose

Next time you've got wallpaper to remove, you might consider this 2-part formula. It comes with a money-back guarantee. Mix its powder and liquid components with water to yield 2 gallons of remover gel. Next, apply it to the wall covering and let it soak. Then, scrape off the softened paper. The company says that 2 gallons can remove 2000 sq. ft. of wallpaper. The product costs $6 to $8 per gallon at paint stores and home centers. For more information, contact Roman Adhesives, 824 Calumet St., Calumet City, IL 60409; 800-488-6117.

Hot Dishes

RCA brings more features to DSS with its third-generation dishes. The integral dipole antenna pulls in local TV channels. A new, 32-bit processor speeds navigation through the system's expanded interface functions. An on-screen interactive control banner displays icons of frequently used functions, and the entire program guide can be searched for specific subject matter. System prices start at $499 at electronics and satellite dish retailers. Contact RCA/Thomson Consumer Electronics, 10330 N. Meridian St., Indianapolis, IN 46290-1024; 800-336-1900.

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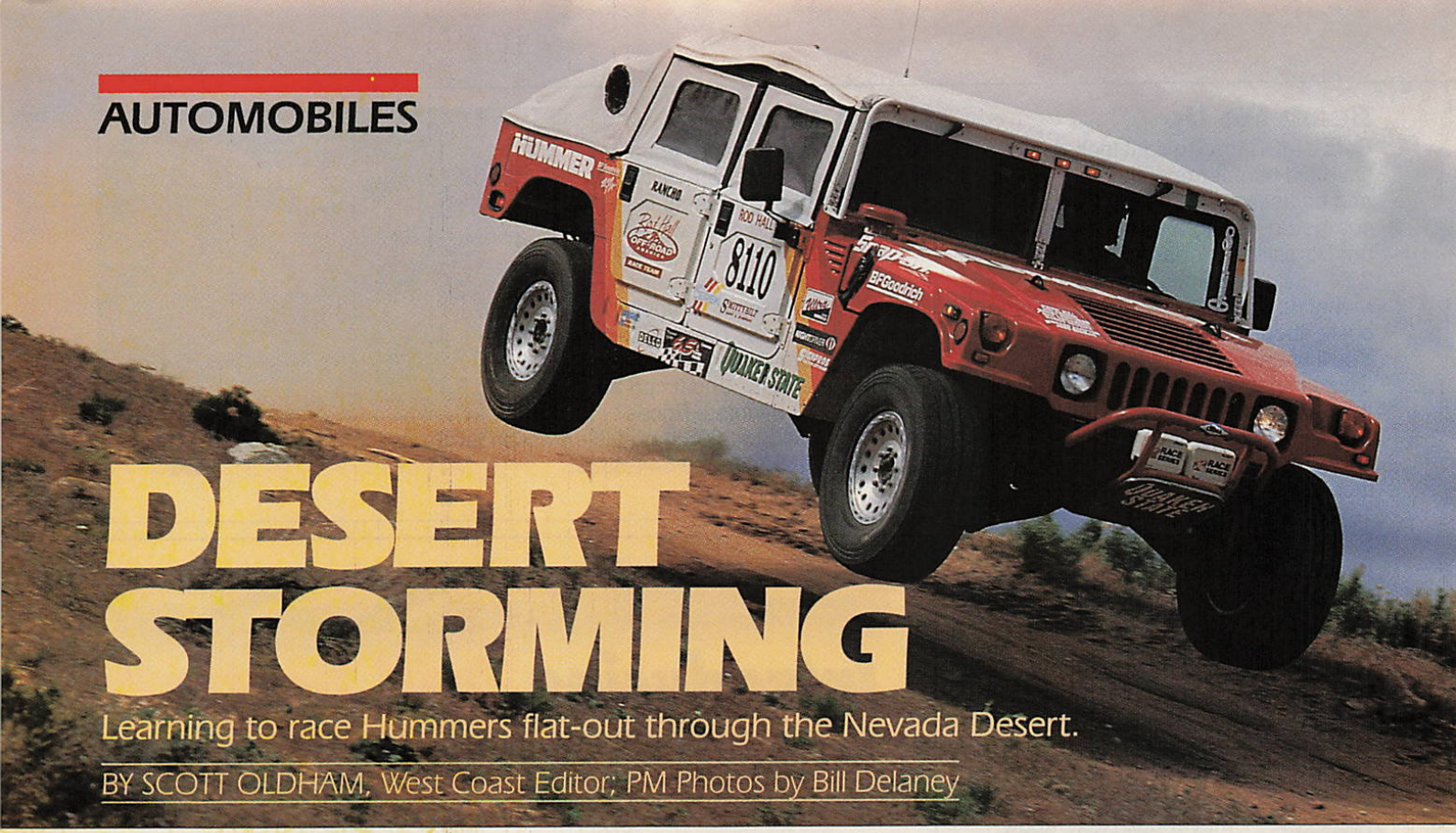

DESERT STORMING

Learning to race Hummers flat-out through the Nevada Desert.

BY SCOTT OLDHAM, West Coast Editor; PM Photos by Bill Delaney

● Cinched tight, the 5-point harness digs into my hips and shoulders. I am about to pilot this patriotically painted Hummer over 7 miles of Nevada desert—7 miles that will test the limits of this 4-ton behemoth, my driving skills and my bladder.

I look over to my instructor, Chad Hall, who is riding shotgun, for some last-minute words of advice. A former Baja 1000 champion and son of 14-time Baja 1000 winner Rod Hall, I am sure Chad will pass on a bit of wisdom, some insight he learned from his eight years of racing and 10 years of teaching. And he does: "Let's bring it back in one piece."

This is the Rod Hall Performance Off-Road Driving School, the Nevada desert edition (702/331-4800). For East Coasters, there's also a school in Jacksonville, Florida, that offers short courses. The Nevada school and course simulate big-time desert racing, like the Baja 500 and 1000, and teach the skills necessary to finish those races with you and your truck in one piece. The short course in Florida (904/359-8440) is more like driving on a motocross track—just as exciting, but very different.

We spend the first of two days in the "Flag" truck, the very truck that won the Stock Full-Size class of the 1993 Baja 1000 in the hands of Rod Hall and finished the 4800-mile Dakar Rally with Chad driving. Its 6.5-liter normally aspirated GM diesel makes 190 hp and 310 ft.-lb. of torque, which is sent through a 4-speed automatic transmission. With 8000 pounds to pull, it's slow, but it's ideal for teaching left-foot braking, vehicle placement, and how to develop a rhythm and read the terrain.

It also teaches you how to adapt to changing conditions. "Anybody can drive the truck fast, but as fuel is used the truck changes and alignments change, and a good driver adapts to the changes," Chad says.

This Dakar Rally veteran is now a teaching tool.

Our man belts in next to Baja 1000 winner Chad Hall for his Hummer lessons.

After lunch on the second day, we move up to the white Hummer, the very truck that won its class in the 1996 Baja 1000. It's powered by a 210-hp 6.5-liter turbodiesel that makes 430 ft.-lb. and weighs in at "only" 6000 pounds. We also move to a more intricate 11-mile course with bigger jumps and longer straights. Where the Flag truck would approach 70 mph, this truck does 80. Over rises, where the Flag truck gets light, this one flies and lands as gently as a paper plane. Its eight shock absorbers and big 17-in. BFGoodrich tires help keep your teeth in your gums when it all comes back down to earth. The landings are surprisingly—no, amazingly—smooth and shockfree.

Even if the Baja 1000 is not on your "to do" list, hammering a Hummer over jumps is not a bad way to spend a couple of days. Our 2-day jamboree cost $2000 and is only one of several courses offered. Who knows, you may be the next Ivan Stewart or Rod Hall. I certainly am not. PM

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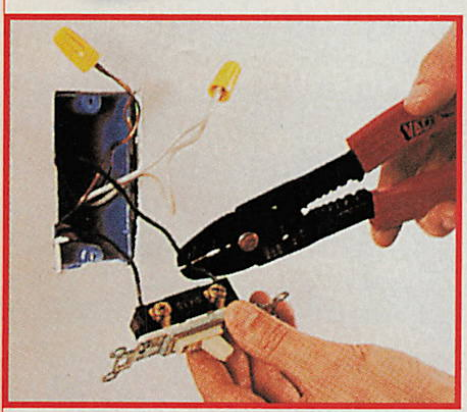

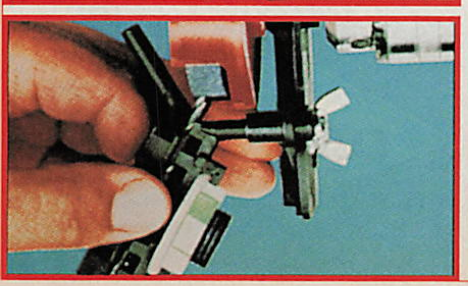

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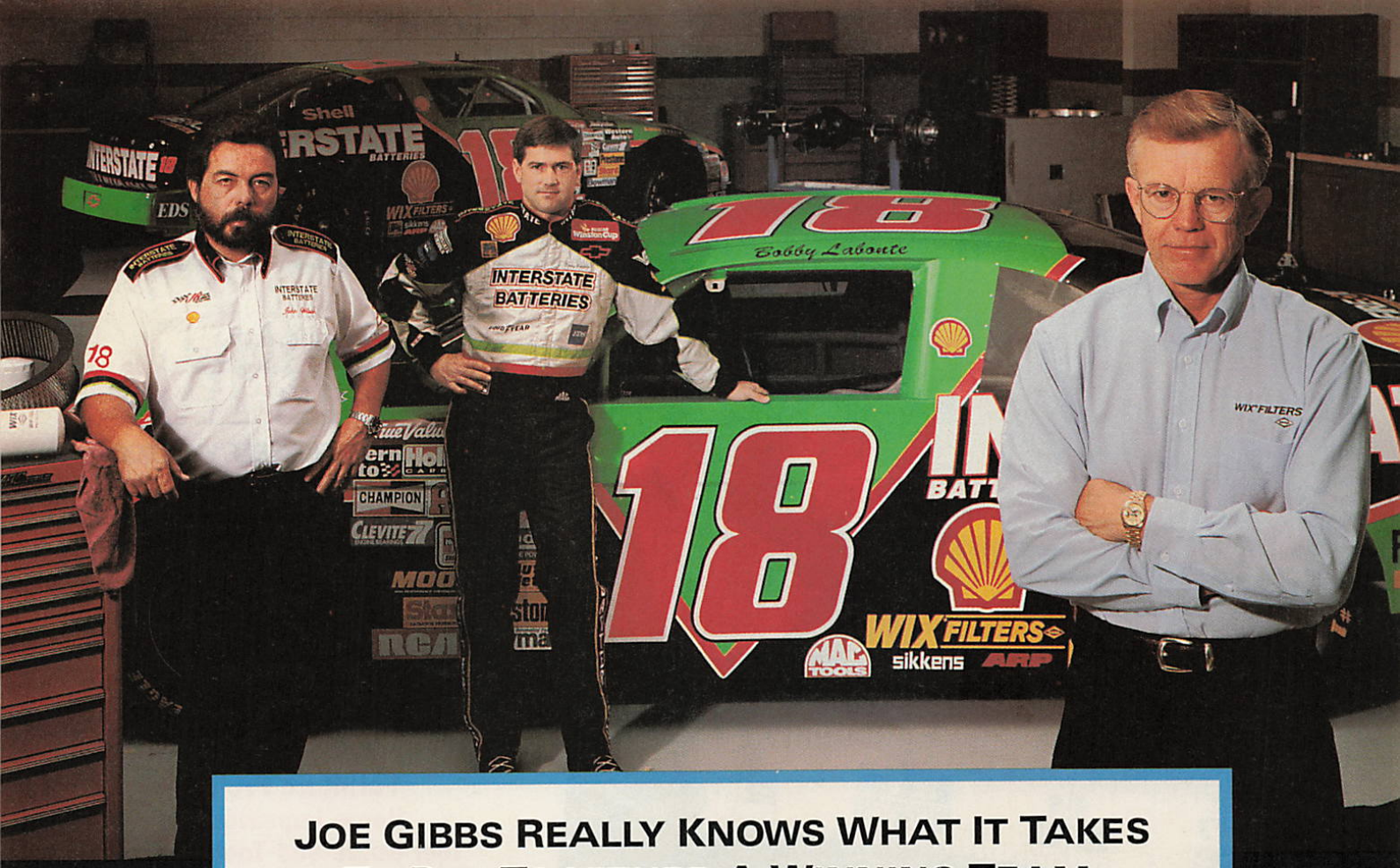

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DANA

CAR CARE

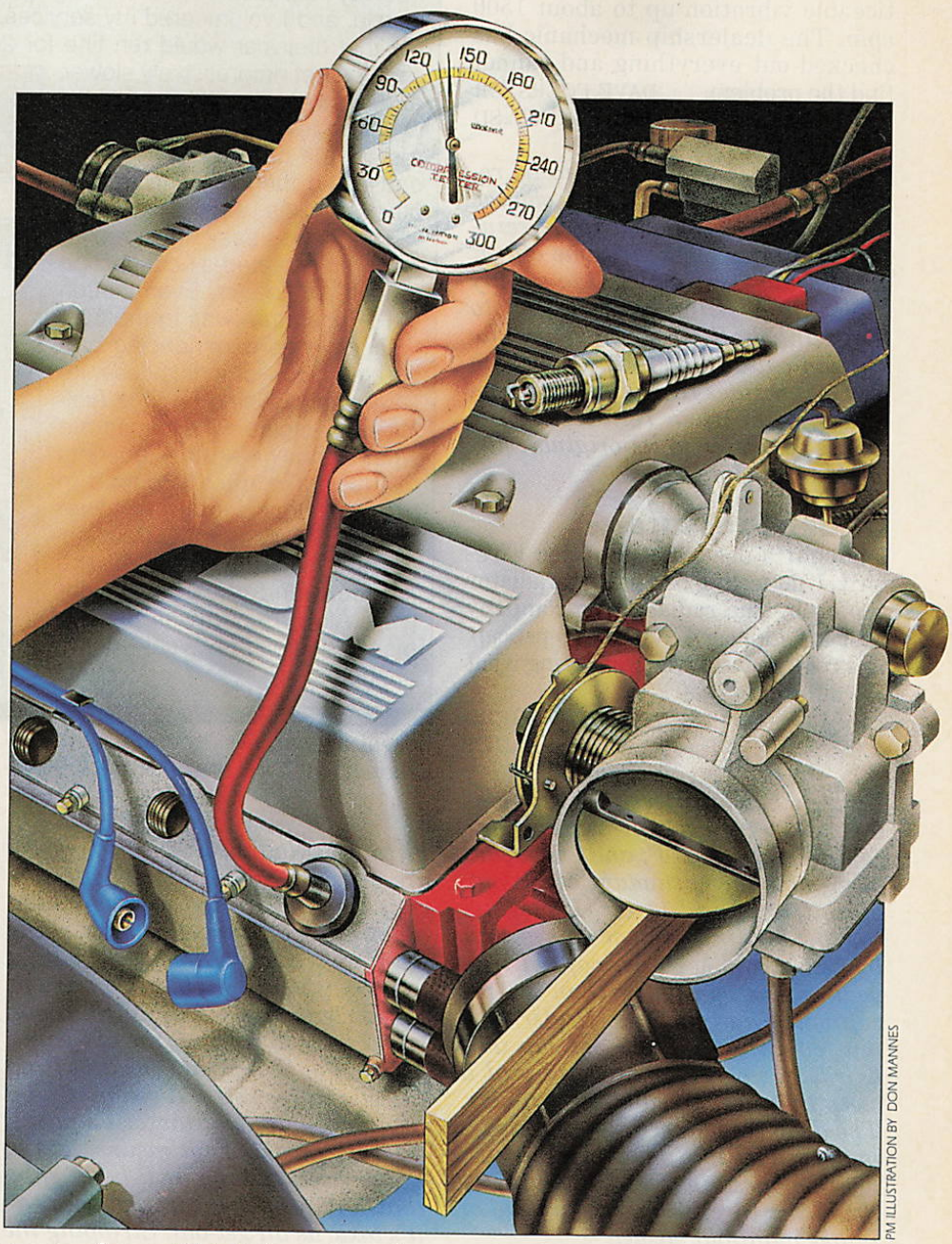
CAR CLINIC

BY MIKE ALLEN,
Associate Automotive Editor

Decapitation

I have a 302-cu.-in. V8 engine that's run 106,000 miles. The left cylinder bank shows 142-psi compression on all four cylinders. The right bank is as follows: 142, 127, 124 and zero to 90 psi. The last cylinder swings from zero to 90 psi with every turn of the motor. Is this a valve, valve spring or head gasket thing? It seems that everyone I ask gives a different answer. There's no water in the oil, and no oil in the water. Is there any way to check without tearing off the cylinder head? What is the normal compression pressure for this engine?

TERRY HALL
VIA INTERNET



PM ILLUSTRATION BY DON MANNES

I suspect you're going to wind up removing one cylinder head, Terry. At least.

In theory, the correct pressure is variable. The exact pressure reading you see on your compression gauge should be equal to atmospheric pressure multiplied by the engine's compression ratio. You'll rarely see this, for reasons I'll detail later. More important is the consistency of the readings between cylinders. I'm worried that your battery got discharged or your engine cooled off before you completed your readings.

Here's how to do a compression check correctly. Start with a cold engine. Crack all the spark plugs loose, turn them out five to six turns, and then tighten them to 5 to 10 ft.-lb. Start and warm up the engine to normal operating temperature. Be sure the battery is in good condition and fully charged, as you want the engine to spin over rapidly until the end of the test.

Disable the ignition in a fashion that won't damage the electronic-ignition amplifiers. (You'll have to consult the appropriate service manual for this.) Then, remove all the spark plugs.

Prop the throttle open with a wooden stick or the plastic handle of a screwdriver. This is important, because you want the cylinder to get all the air it needs to completely fill.

Install the compression tester in one cylinder, and turn the motor over for six to eight compression strokes, or until the gauge stops climbing. Record the gauge reading and move to the next cylinder promptly to make sure you finish before the engine cools significantly.

This will give you consistent readings. Because of variances in the barometric pressure, speed of cranking, altitude above sea level and what brand of gum you chew, the pressure will be lower than the theoretical maximum. No matter. What's important is the variation between cylinders, and 20% is enough to constitute a problem.

In your case, you have a problem with one cylinder. You could turn the engine to Top Dead Center on the compression stroke for that cylinder and put compressed air back into the cylinder to see where it's leaking, such as back into the intake, out the exhaust or into the crankcase. Nevertheless, this will likely be an exercise in futility. If you've taken your compression test correctly, that head's probably going to have to come off.

Shake It Up, Baby

I recently had the rear main-bearing seal replaced on my Explorer at 31,000 miles. Now, there is a very noticeable vibration up to about 1500 rpm. The dealership mechanic has checked out everything and cannot find the problem. DAVE FOERSTER
BROOKINGS, SD

The torque converter had to be removed from the flex plate to change the seal. It's supposed to be reinstalled exactly where it came off—it should have been indexed to exactly the same position with respect to the crankshaft. It sounds like the mechanic didn't do that. There's no fix for it besides removing the transmission and then reindexing the torque converter to its original, factory-balanced position.

Under Pressure

I bought a used 1985 Pontiac Firebird. I noticed it has a 7-psi radiator cap on it. The radiator cap company says it's supposed to use a 16-psi cap, so I replaced it. I was wondering what the difference was.
NAME WITHHELD
VIA INTERNET

Liquids boil at a certain temperature at atmospheric pressure, in the case of water 212°F, and somewhat higher for the customary 50/50 mix of antifreeze and water. Pressurizing the cooling system raises that temperature. A 16-psi cap will let your engine run hotter than a 7-psi cap will before it boils. Under normal conditions, the 7-psi cap will work, but a really hot day and a steep hill might create some trouble. The downside to the higher pressure is the higher likelihood of blowing a hose or bursting a radiator tank or the heater core, or blowing a head or intake manifold gasket.

Why was there a 7-psi cap on your 'Bird? 1. Someone who learned about cars back in the '50s—when cooling-system pressures were lower—thought it was better. 2. Someone didn't know or care, and they used what was handy. 3. Someone was trying to cover up a bad intake manifold or head gasket that was leaking.

Wheelie Sharp

My alloy wheels used to have some shiny surfaces and some dull, textured areas. Over the years, the shine has gotten dull, and the textured areas have gotten dirty and won't clean up. How can I restore them to a decent appearance, even if it's not the original look? BERNARD BUSH
JACKSONVILLE, FL

Virtually all aluminum-alloy wheels are painted. Sometimes it's a clearcoat over machined and polished aluminum, but sometimes it's shiny paint covered by clearcoat. So, a light touch with fine rubbing compound might clean up the dull finish. If not, you'll have to strip off the old paint, polish the aluminum on a buffing wheel and repaint. I'd recommend a urethane-based automotive paint, such as Imron. That means getting the spraying done at a body shop that has proper protective gear, as it's toxic as all get-out. Stripping the old paint won't be easy either, because chemical strippers aren't very effective against the very tough automotive paints used on wheels.

Lastly, don't ever sandblast or beadblast alloy wheels. The sandblasting leaves the surface of the aluminum very porous—which is good for paint adhesion, but leaves millions of small stress risers and makes the wheels much weaker. PM

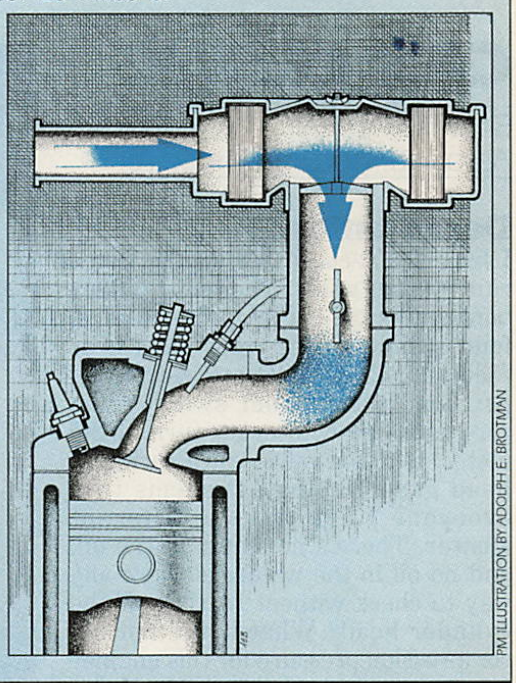
DO YOU HAVE A CAR PROBLEM?
Just ask Mike about it. Mail your question to Car Clinic, Popular Mechanics, 224 W. 57th St., New York, NY 10019. While letters, faxes or phone calls cannot be answered individually, problems of general interest will be discussed in the column.

CAR CARE TIP

Chill, Dude

● It was a dark and stormy night. Really. So I felt compassion for the couple pulled over in the freeway rest stop with the hood up in the cold drizzle, and I volunteered my services. They told me that their car would run fine for 20 miles or so, then get progressively slower and slower. They'd stop, and within a few minutes, it would restart, run rough for a few seconds, and then run fine for another 10 miles.

The fix was easy. I just reconnected the heated-air connection to their air cleaner. Even though the temperature was in the 50s, their car was experiencing carburetor icing—or in this case, intake-manifold icing on their fuel-injected engine. The humid air, when it navigated the labyrinth of the intake tract, dropped in pressure low enough to lower the temperature below freezing, plating out the water on the manifold and choking the engine. After a short wait, the ice melted and off they went—until it happened again.



PM ILLUSTRATION BY ADOLPH E. BROTMAN

SERVICE TIPS

● Does the in-console CD player skip while you're driving your 1995-97 Ford Explorer or 1997 Mercury Mountaineer? Dealers will install a kit (PN F77Z-78044N19-BA).

● If you bring your 1995-96 Chrysler Cirrus/Dodge Stratus or 1996 Sebring built before Sept. 15, 1995, to a dealer, he'll automatically install a new air filter (PN 4873153). The old one may be torn.

● GM warns that improper installation of any electronic accessory (like a remote starter) in a 1995-96 light truck may cause its transmission controls to prevent upshifts.

● BMW says it's not necessary to replace front and rear shock absorbers in pairs on any of its cars (except M3 and M5) if only one goes bad before 30,000 miles.

● Is there a tapping noise coming from the passenger-side dashboard of your 1995-96 Hyundai Accent or 1996 Elantra? The likely cause is an a/c line rubbing on a screw or grommet.

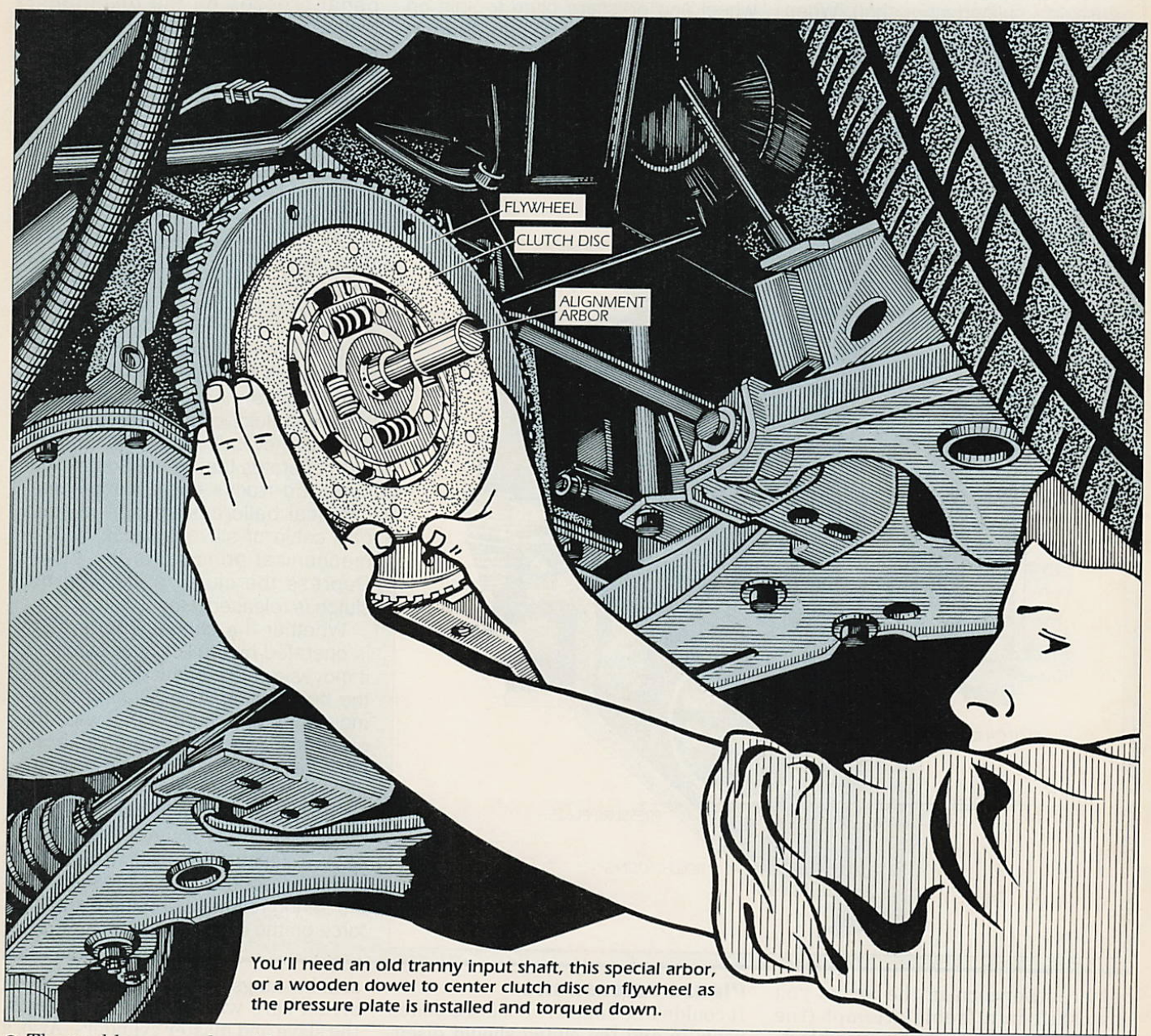
● If your 1994 Saab 900 (except Convertibles) or 1995 900 Convertible suffers from a wicked front-end vibration, it may need to have hydraulic suspension arm bushings retrofitted.

SATURDAY MECHANIC

REPLACING YOUR FRONT-DRIVE CAR'S CLUTCH

DEGREE OF DIFFICULTY HARD

BY JOHN DECKER



You'll need an old tranny input shaft, this special arbor, or a wooden dowel to center clutch disc on flywheel as the pressure plate is installed and torqued down.

● The problem was almost imperceptible at first: Going up a slight hill at highway speeds, you noticed that the engine was revving higher even though your car wasn't going any faster. Backing off the gas or dropping into a lower gear made the problem go away each time.

But that was a month ago. Now you spend your days looking for routes that have no hills, because even a slight incline causes the engine to rev wildly while the car slows down. There's also the smell of burnt

Rate Your Mechanical Ability

With each installment of Saturday Mechanic, you'll notice that we've added a level-of-difficulty rating for the procedure we're discussing. It's to help you know instantly just how astute a mechanic you'll need to be to attempt any particular Saturday Mechanic. One wrench: If you can hang a picture, you'll be okay. Two wrenches: You need to have a basic knowledge of auto mechanics and procedures, plus a basic set of tools. Three wrenches: Strictly for the advanced wrench-turner. But if you don't feel up to attempting the job yourself, read it anyway. You'll then be able to have an intelligent conversation with your professional mechanic.

DEGREE OF DIFFICULTY EASY

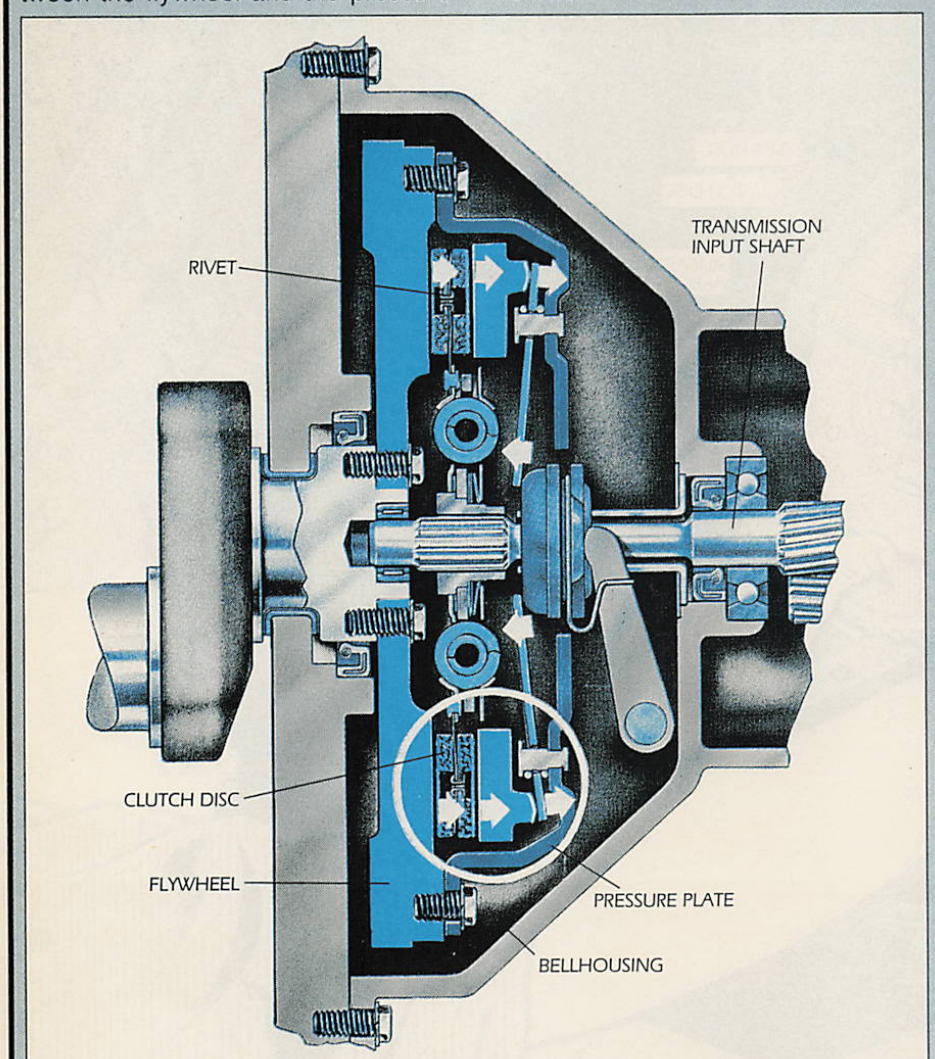
DEGREE OF DIFFICULTY MODERATE

DEGREE OF DIFFICULTY HARD

PM ILLUSTRATION BY RUSSELL J. VON SAUERS

How It Works: Clutch Play

● At the heart of the clutch assembly is the clutch disc. It has friction material, similar to brake-lining material, on each side and a splined hub that slides back and forth on the transaxle's splined input shaft. When the clutch pedal is not depressed, the clutch disc is tightly clamped between the flywheel and the pressure plate to firmly connect the engine to the transaxle. Depressing the clutch pedal allows the clutch disc to spin freely between the flywheel and pressure plate, allowing the engine, flywheel and pressure plate to spin on their own, while the splined input shaft and transaxle freewheel with the disc.



The clamping force that engages the clutch comes from a large spring, or series of springs, located inside the pressure plate called a diaphragm. Depressing the clutch pedal presses on the diaphragm spring, causing the pressure plate to move away from the clutch disc, and the clamping force diminishes until the engine can spin independently of the transaxle.

To get the clutch moving, the clutch pedal is connected to a sheathed cable or a hydraulic master cylinder and slave cylinder. The cable system works much like a heavy-duty version of the brake-caliper cable that can be found on a 10-speed bicycle—depressing the pedal pulls on the cable to release the clutch. With the hydraulic system, pressing on the clutch pedal moves a piston in the master cylinder, which displaces fluid, causing the piston in the slave cylinder to move. This, in turn, operates the clutch. Some older cars and trucks use a simple mechanical bellcrank linkage instead of a cable or slave cylinder, but the mechanical principle is the same: Depress the clutch pedal and the clutch is released. How?

Whether the clutch-pedal system is operated hydraulically or by cable, it moves a release fork that pivots on the bellhousing. The pivoting action moves the end of the fork toward the pressure plate. A throwout bearing (also called a clutch-release bearing) at the end of the release fork applies even pressure to the diaphragm spring and the pressure plate moves back, releasing the clutch disc. Let the clutch out, and the pressure on the spring releases and the clamping force on the disc returns. —*J.D.*

buttered popcorn in the air as you downshift in a feeble attempt (the semi driver on your bumper is blasting his air horn) to reduce the engine load and get the car going again. Your biggest fear is that you'll end up backing down the hill. The problem isn't in the engine or transaxle. All that slipping is caused by a worn-out or misadjusted clutch.

Compared to other automotive devices, the clutch is decidedly low-tech (see How It Works, above). And while replacing and adjusting the clutch doesn't require exceptional skill or high-tech equipment, there are some things you should look out for.

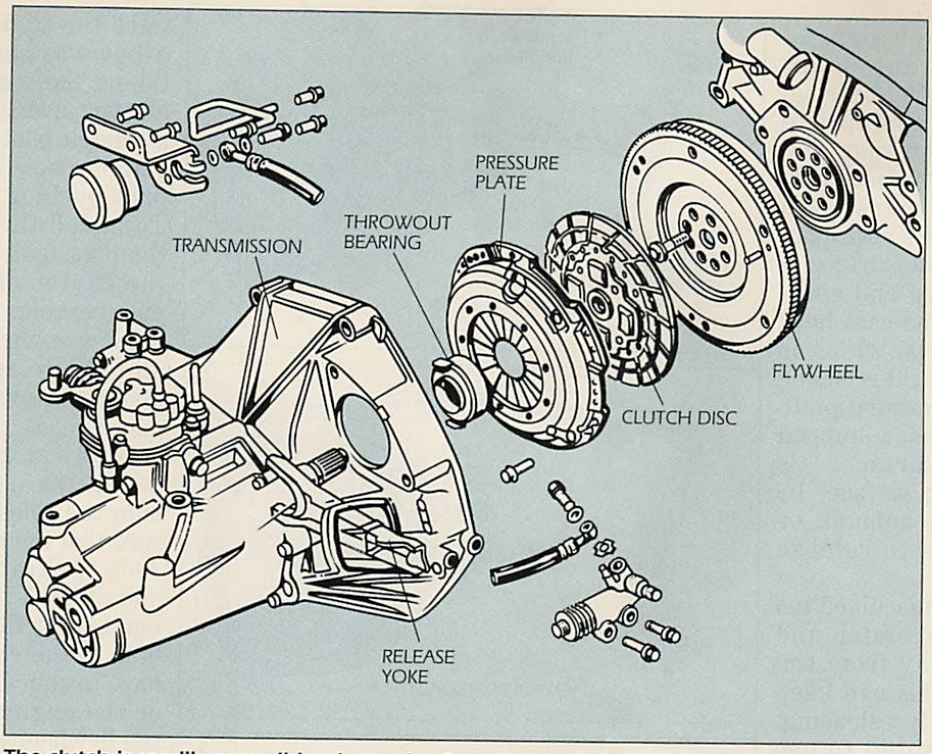
Please release me

It couldn't be simpler: Push the clutch pedal in and the clutch should disengage. However, if the clutch doesn't fully disengage, you'll hear a lot of grinding during shifts or when you try to put the car in gear. "A lot of people immediately think there's a problem with the clutch disc or pressure plate when the clutch doesn't disengage," says Gabe Vajda, a technician with LuK, a maker of clutch parts.

"Any play in the clutch-pedal parts soaks up travel, so the clutch won't fully release," Vajda cautions. He says that before you remove the transaxle and clutch, it's wise to check the pedal-arm bushings and the actuating cable, or, on cars with hydraulic systems, the slave and master cylinders. Also, a nonreleasing clutch could even be caused by something as simple as carpeting under the pedal that's too thick, which has been the case with some 1988-90 Chevy Beretta and Corsica models. Trimming away insulation under the carpet will restore full pedal travel.

If a clutch isn't releasing, start by manually prying the release arm at the bellhousing with a screwdriver. If the arm moves freely and the clutch releases there, chances are good that the problem lies outside the bell-

housing. On cable-operated clutches, there could be too much play in the cable, which can reduce travel. To reduce cable play, find the adjusting nut at the top or bottom of the cable and adjust the cable to the proper specifications. On hydraulically operated clutches, air in the lines, or a worn master or slave cylinder, can result in reduced travel. To bleed the air, top off the master cylinder reservoir with brake fluid. Place a piece of hose on the slave cylinder's hydraulic vent, then place the other end of the hose into a partially filled glass bottle. Open the vent, then have an assistant repeatedly depress the clutch pedal slowly until bubbles coming from the end of the vent line disappear. After tightening the vent, clutch travel should return to normal. If it doesn't, then the slave and master cylinders should be replaced.



The clutch is readily accessible—but only after removing the transaxle from the engine. You'll need to remove or unhook the axles as well.

Removal and inspection

Barring adjustment, the only way to fix a slipping clutch is to replace it. Installing a new clutch is very straightforward. But you have to make sure the work is done right, since fixing any mistakes usually means removing the transaxle—something you don't want to do more than once. It's best to consult a service manual for instructions specific to your vehicle. The following is a general procedure for replacing a clutch.

Start by disconnecting the battery positive cable. Then, while working under the hood, prepare the transaxle for removal by disconnecting the clutch cable or hydraulic slave cylinder. Also, remove or disconnect items that prevent the transaxle from being removed, such as backup-light wires, air-cleaner ducting, exhaust pipes, the starter motor, speedometer cable and other items. If you are in doubt as to exactly what needs to be removed, consult a manual.

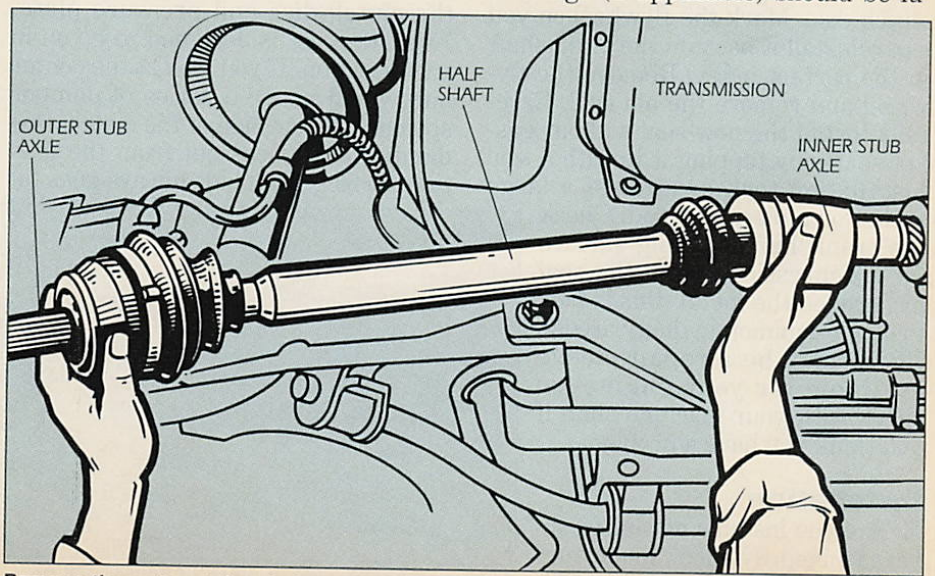
Next, chock the rear wheels and jack up the front end of the car and support it with stands. Working from under the car, remove any additional parts that you couldn't reach from under the hood, including the bolts that hold the axle shafts to the transaxle.

To remove the transaxle, you normally have to remove one or more engine mounts. But before you can start removing them, you'll have to support the engine. With many cars, it's possible to support the engine from underneath by placing a jack under the oil pan. But on other cars, a special engine-support rod that allows the engine to hang while the transaxle is out must be installed under the hood. Again, consult a manual for the proper method.

To disconnect the transaxle from the engine, support the transaxle with a jack and remove the bolts from around the flywheel bellhousing. Next, slide the transaxle away from the engine until the transaxle input shaft clears the pressure plate, then lower the transaxle to the ground and roll it from under the car and out of the way.

Once you have removed the transaxle, you will then be able to access the pressure plate and clutch disc. Remove the bolts from around the pressure plate, then remove the plate and clutch disc. Inspect the friction surface of the flywheel. If it is scored, checked or shows signs of hot spots, it must be removed, machined at a machine shop and then reinstalled. Keep in mind that it's good practice to have the flywheel machined so the clutch disc has a proper surface to break in on. If you don't have the flywheel machined, sand it lightly with medium-grit sandpaper wrapped around a small block of wood.

When inspecting the flywheel, also inspect the pilot bearing or bushing at the center of the flywheel. The needle bearings (if applicable) should be lu-



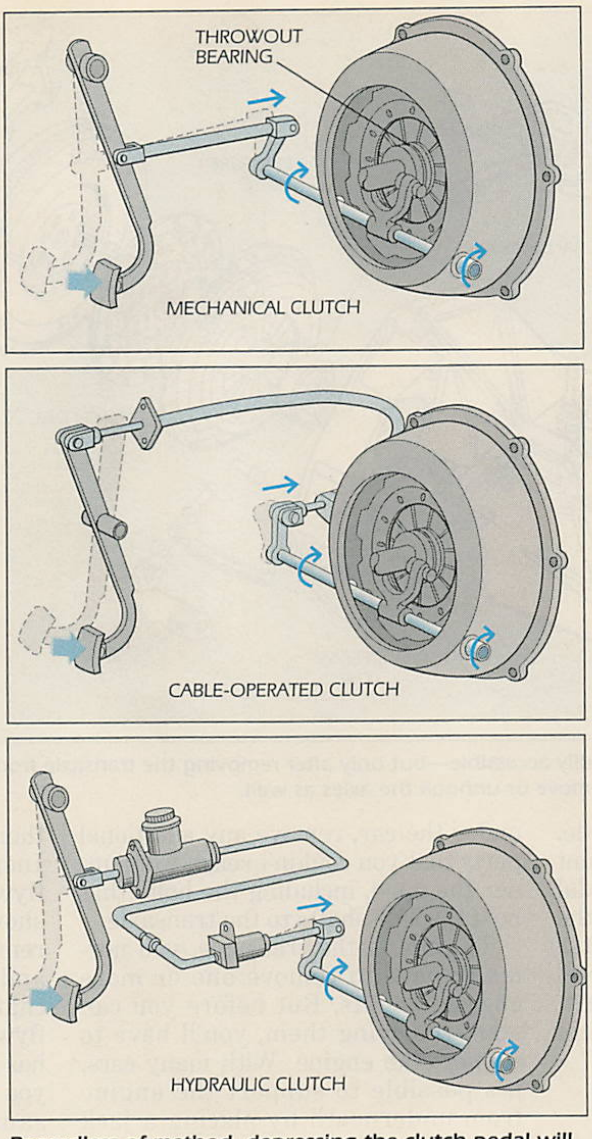
Remove the outer stub axle from the hub, and then pull the entire axle free of the transaxle. You may need to plug the inner socket.

PM ILLUSTRATIONS BY DAN HATALA

bricated and show no signs of galling. If there's any doubt about the quality of the bearing, remove it with the appropriate tool and install a new one. You should also inspect the back side of the flywheel for signs of oil leakage at the engine's rear main seal. If oil reaches the surface of the clutch, chattering and grabbing will result. Some cars have "stepped" flywheels, which is when the clutch disc rides on one surface and the pressure plate bolts to a surface that's stepped above the clutch surface. It's important that both surfaces be machined the same amount, or slipping or failure to release could result.

If the flywheel is machined too much, it moves the clutch and pressure plate away from the release bearing. This can keep the clutch from fully releasing. You might be tempted to use shims between the crankshaft and flywheel to move the clutch assembly toward the release bearing. However, it's possible for a thin flywheel to burst at high rpm. The only safe alternative is to replace the worn flywheel with a new one.

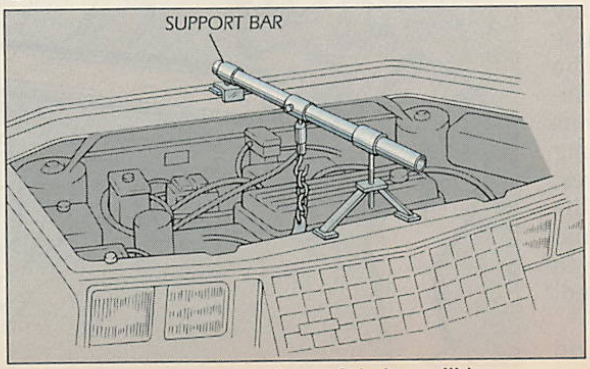
Inspect the transaxle's input shaft seal to be sure it isn't leaking. (There's no need to inspect the clutch disc, pressure plate or release bearing, since you'll be replacing those.) If the seal is leaking, replace it. Next, look for leakage at the engine's rear main seal. If there's more than a hint of seepage there, this may well be the reason for the early demise of the clutch disc. Mark the flywheel so you can reinstall it back on the crankshaft in the correct index. Remove the flywheel and remove the old seal. Carefully install the new seal without gasket sealer by tapping it in with a seal installation tool, or at least a large socket or a piece of wood. Check the crankshaft's sealing surface for a depression where the seal has eroded the metal (this is particularly common in dusty areas). There may be a repair sleeve available for your engine, so check with your machine shop if you think you have a problem.



Regardless of method, depressing the clutch pedal will push the throwout bearing against the pressure plate. There should be some adjustment mechanism as well.

Installation

Before you install a new or freshly machined flywheel, make sure the crankshaft flange is clean. After placing the flywheel on the flange, tighten the bolts in a star pattern to the proper torque specification. There are two tricks to installing the clutch disc and pressure plate. First, the disc is designed to go on in one direction. If you look at the center hub, you'll notice a series of damper springs. On one side of the clutch, this damper hub sticks out from the friction surface. That side always goes toward the transaxle. Put it in the other way, and you'll soon be taking the transaxle out to do it all over again. Second, you'll need a "clutch pilot tool" to install the clutch disc so it aligns with the pilot bushing in the crankshaft. To install the disc, slide it onto the pilot tool, then securely stick the center of the tool into the pilot bearing. Install the pressure plate over the clutch disc, torque all bolts to specifications using a star pattern, then remove the pilot tool.



A support bar or a stout piece of timber will be necessary to support the engine while the tranny is out.

Before installing the transaxle, install the new release bearing onto the release fork, then make sure that the fork operates freely. Jack the transaxle into position and slide it forward so that the input shaft slides into the splined hole in the clutch disc. You may have to spin either the input shaft or the engine's crankshaft (and the flywheel and clutch along with it) to get the splines to align. Don't force the input shaft into its splined hole. When everything's properly aligned, the shaft will slide right in. If it doesn't slide right in, don't force it. Back it out and try again.

Never let the transaxle hang unsupported from the engine, since this can lead to damage to the pilot bearing, input shaft and front input shaft bearing.

After installing and torquing all the bellhousing bolts to spec, you can reinstall any motor mounts that you had removed, the drive axles, as well as any other components under the car. Once the underside work is done, remove the jack holding the transaxle and lower the car to the ground. Reinstall any underhood components.

You don't really have to replace the clutch cable at this time, but because it costs less than $50, replacing it is good insurance against trouble later on. In any case, adjust the cable to the proper amount of free-play.

Most hydraulic clutch actuators are self-adjusting and, therefore, have no free-play. Still, you'll want to make sure the self-adjusting action is working properly. To do that, simply push the slave cylinder piston back into its bore. If it moves, the system is working properly. If it doesn't move, it means the slave cylinder's pressure-relief orifice is clogged and the slave cylinder should be replaced. PM

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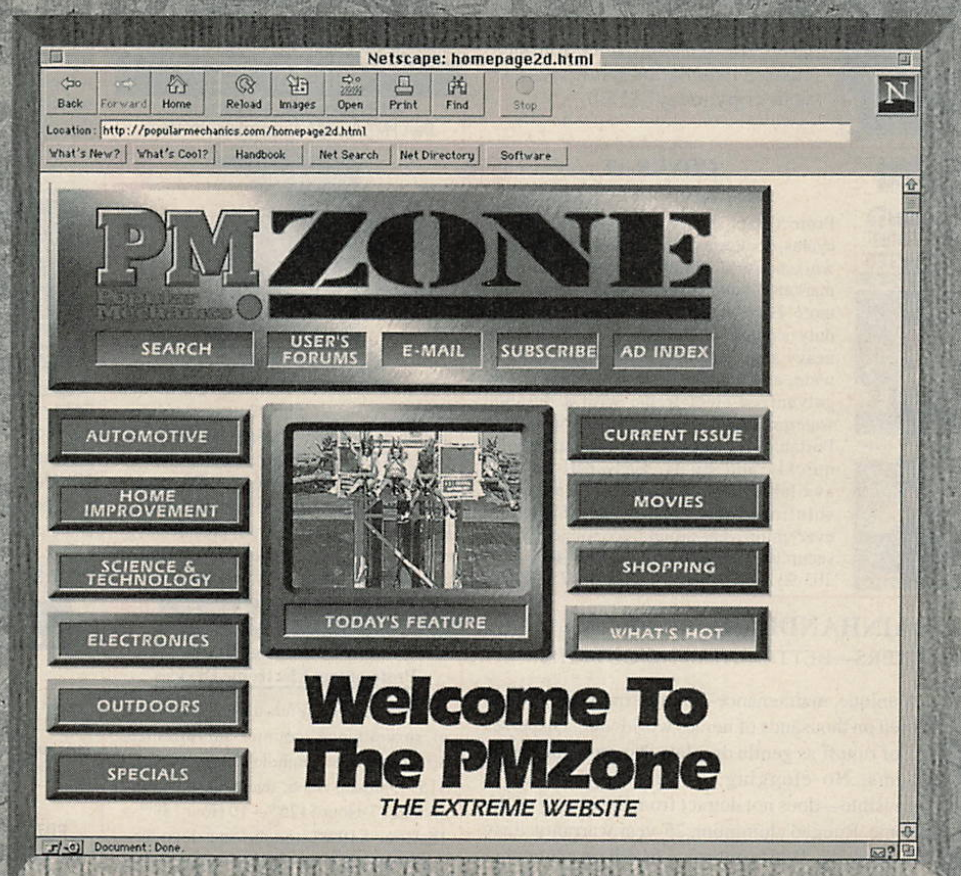

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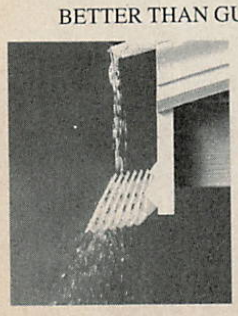

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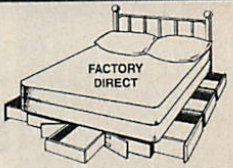

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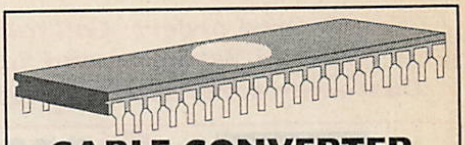

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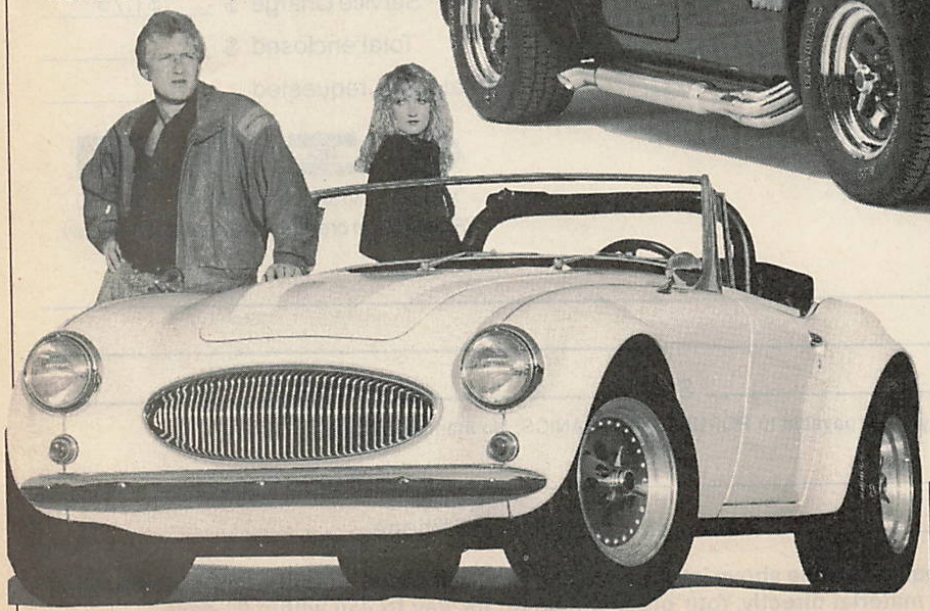

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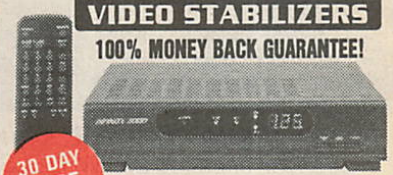

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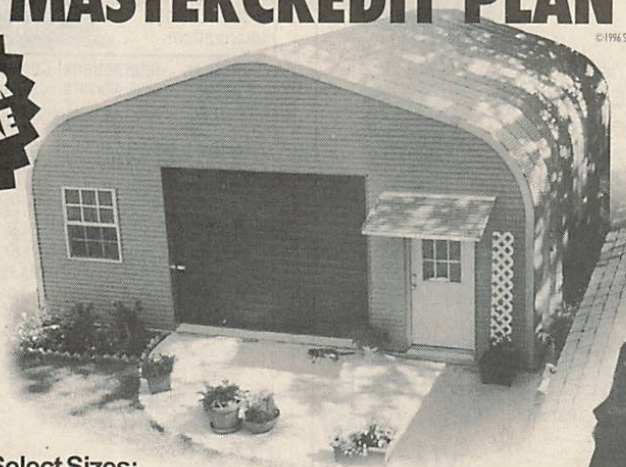

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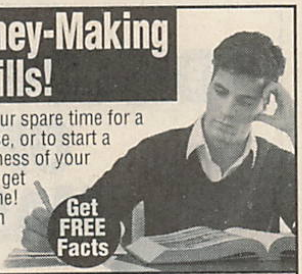

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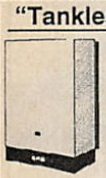

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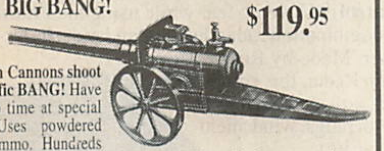

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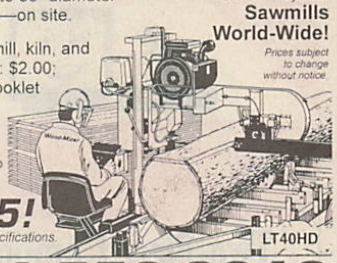

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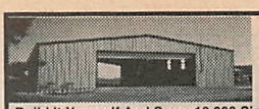

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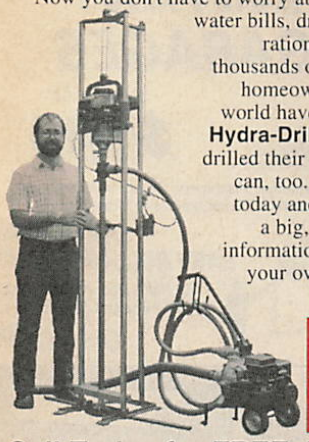

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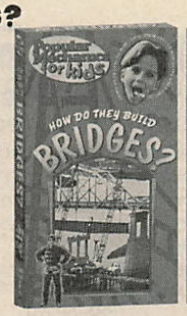

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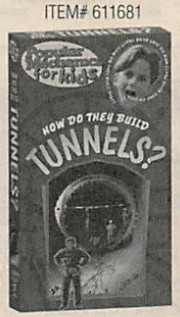

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	high blood pressure	controlling cholesterol	quitting smoking	relieving allergies
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Plan to see a doctor	❑	❑	❑	❑
Taking Medication	❑	❑	❑	❑
Seeking information on treatment/remedies	❑	❑	❑	❑
Changing your diet	❑	❑	❑	❑

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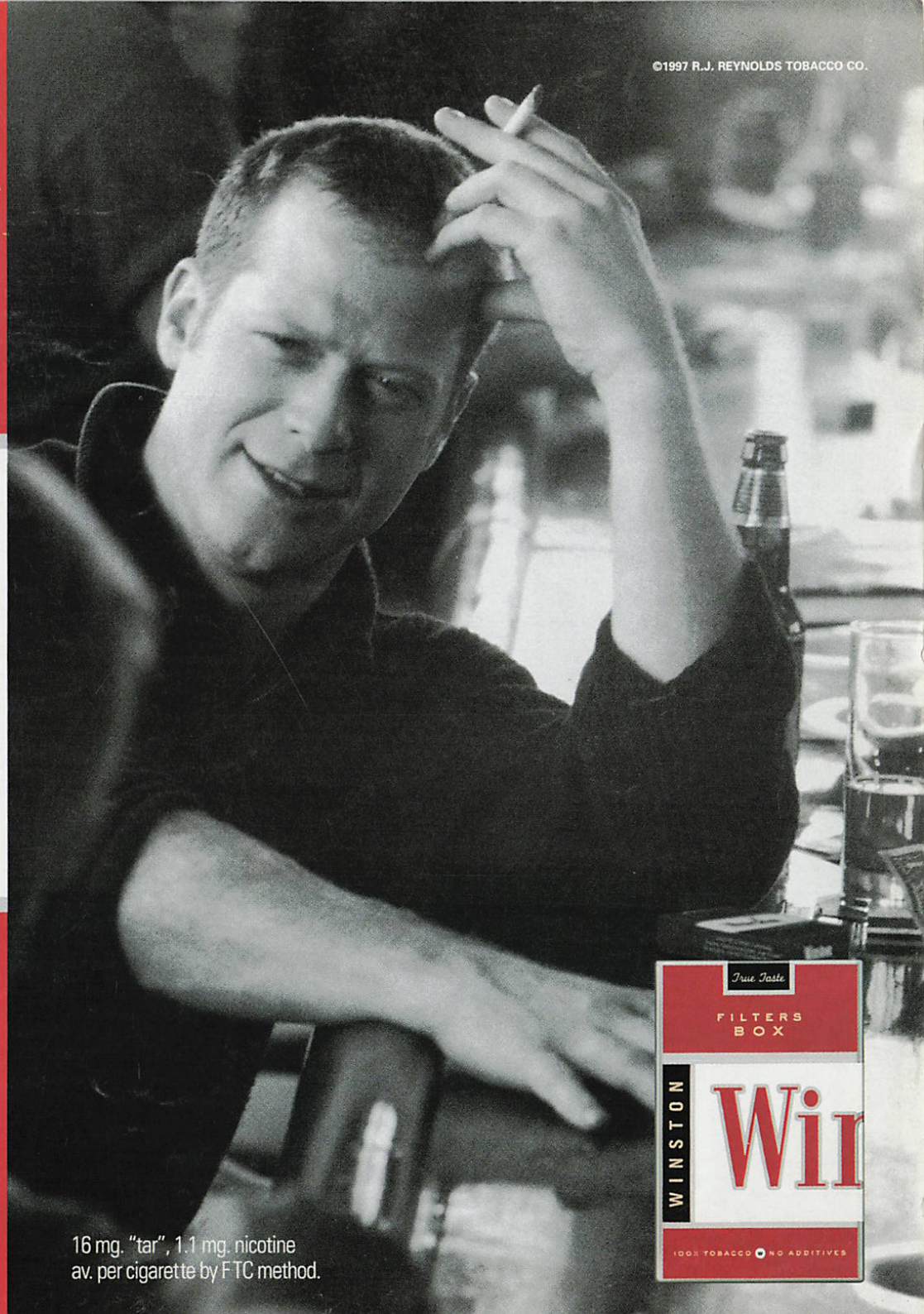

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